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ENGINEERING SCHOOL OF PRACTICAL SCIENCE

THE ENGINEERING MAGAZINE

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EVIDENCES OF A REVIVAL IN BUSINESS.

AS REFLECTED IN THE NEW YORK MARKETS.

THE seventh volume of THE ENGINEERING MAGAZINE opened, in April last, with a leading paper on "The Outlook for an Improvement in Business," consisting in part of a forecast which has been so strikingly verified that it seems proper, at the threshold of the eighth volume of the Magazine,—which happens, fortunately, at a period of quickening of business,—to refer both to the subject and to the article itself. The writer of this paper expressed the belief that, "after the long siege of depression and general financial and commercial demoralization we have had in the United States, the turning-point has finally been reached." It was mentioned as a hopeful sign that "there has rarely been a time when the outstanding obligations of merchants were so small," besides which reference was made to the plentiful supply of money and the greatly increased wealth of the United States within recent years. As for the then pending legislation at Washington, the writer said: "With the settlement of the tariff question the merchants will soon adjust themselves to the new conditions, and business must necessarily drift back to its normal state." Going more into detail, the article continued:

> There was no fall trade last year and the delay in legislation at Washington has killed the spring trade. The people are now anxiously looking forward to the crop period; and if the harvest is up to the average and we have a good foreign demand, as it is fair to think that we will have under existing low prices, the entire purchasing power of all our crops for this year will come against a greatly diminished supply in each and every branch of manufacture. With a people so easily stimulated, so ambitious, and so enterprising as Americans are proverbially known to be the world over, it must be apparent to any thoughtful mind that the stimulation which the marketing of the crops will produce throughout all lines of industry and commerce must restore confidence with a swing; and as a result we may reasonably look for a speedier revival next fall than a long period of depression under other circumstances would permit us to hope for.

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The writer of the above paper, Mr. J. Edward Simmons, president of the Fourth National Bank of New York, when asked to favor the readers of the Magazine with his views on the business situation at the present time, did so in the following words:

"The business outlook has shown decided improvement of late. This has been shown, first, in the recent very heavy sales of merchandise, particularly of dry-goods, the transactions in which have been of unusual volume for the season. The railways have not yet reflected the general improvement, but they will begin to do so with the transportation of the merchandise I have referred to. Very soon the crops will begin to move toward the markets, and they are unusually heavy this year, promising employment for a vast deal of railway equipment. It has been reported that a great shortage exists in the corn crop in the west, but this, I am convinced, has been exaggerated. The crops in the south are very heavy this year, the cotton crop being, perhaps, the largest known. But in addition to this, other crops are now being produced in the south in greater volume than formerly.

"The promise for the near future from all these conditions is good—very good. There is not to be expected any 'boom' in business, but there will be slow and steady improvement. It will be enhanced when England has time to be heard from—when she begins to buy back some of the securities which were unloaded on us in the early days of our late period of depression. It must be remembered that during all of the panic we have not lost any of our existing wealth. At one time a scare prevailed lest our currency should be found on a silver basis, but no reason for such fear any longer exists; on the other hand, the country is on a par with all the great gold-paying nations of the earth. It must be admitted, however, that the purchasing power of the people has not yet returned to the normal standard, but it is rapidly doing so. Wages are on a lower scale now than three years ago, but with the possible exception of rent, every item of living expense has been reduced. A dollar to-day, or perhaps a dollar and a half, will buy as much of the necessaries of life as two dollars would buy a short time ago. In addition to the above considerations, I may add, as having a bearing upon the situation, that in the banking world money is very easy."

NEXT to the banking houses, nowhere else is the effect of good times or the opposite more promptly reflected than in the dry-goods district of New York. Here are stored fabrics which will help to clothe every family—almost every individual—in the United States. Hither come buyers from every state, from city, village, and hamlet—for in these days of cheap travel merchants of every degree come to the metropolis to replenish their stocks. Immediately following the passage of the tariff bill the signs of activity in the dry-goods trade were apparent to all. The custom-house forces were busy with the release of imports which had been delayed until they could be admitted under lower rates of duty ; the hotels were filled to overflowing with buyers of goods ; and the sidewalks were next to impassable with the packages of merchandise awaiting distribution over the country. Views of the situation have been obtained for the Magazine from two representative wholesale dry-goods houses.

The first is from the house of the H. B. Claflin Company : " There is a large number of buyers of dry-goods in this city at this time—far larger than last year at the same date. They began arriving almost at once after the disposal of the tariff bill at Washington. They have come from various parts of the country, but mainly from the South and from the states adjacent to New York, for the reason that the principal cities of the west have become important centers for the dry-goods jobbing trade. The number of buyers visiting this city from year to year is subject to no known rule ; for instance, many dry-goods merchants from Texas may come to New York in one year while in the next they may all stop to buy in St. Louis. Large out-of-town stores are apt to have resident buyers in New York, whose orders are being handed in all the time. But that buyers have come to us this season in good numbers we know. We also know that stocks have reached a low point in stores throughout the country, so that replenishing now is an absolute necessity. To say that the present buying is the beginning of a period of continued business activity would of course be mere guesswork, but we believe that a turning-point has been reached in the depressed condition of the trade, and that better times are at hand. Collections have been very good of late, although it is too early for the returns from the new crops to have gotten into circulation."

The second statement is from Mr. George C. Clark, of the firm of Tefft, Weller & Co : " The number of dry-goods buyers in the city is much larger than at this time last year, though smaller than in 1892, which was an exceptionally good business year. They have been coming from every part of the country, some of them living as far west as California. The fact is becoming realized that New York is, after all, the place to buy goods, though western jobbing centers will always get a share of the trade. The merchants who have come to town are buying freely, but carefully, in a way which indicates that their stocks have become greatly depleted, and that buying now is a necessity if they are to continue in business. Beyond the condition for the moment there is nothing about which we can be certain. But many of the causes which have interfered with trade for some time past have disappeared, and there is nothing now in prospect to further depress business. The agitation at Washington of the silver question was an obstacle to trade while it lasted, but the moment that subject was disposed of there was a marked improvement. Next came the discussion of the tariff, which is also disposed of for the time, much to the relief of business. The new tariff law is not all that we could have asked, but anything in the way of reforming the tariff is better than nothing, and, more than all, it is important to have uncertainties removed. As for prices, the future has already been discounted. Thus woolen goods on which reduced duties go into effect on January 1 are being sold now at prices based upon the new schedule of duties. But there is one element in the business depression of 1893 which has not received, publicly, the attention it deserves. I mean the effect of the World's Fair upon the purchasing power of the masses. Most of the people who went to Chicago last year did not have surplus money enough to defray the expenses of the trip, in consequence of which their bills at the stores remained unpaid, and merchants were unable to buy new goods for the fall and winter trade. I have seen examples of the effect of this factor in last year's trade in several parts of the country, and am satisfied that the effects were very widespread. The trade has been recovering from these effects, however; local collections, though delayed, have been made, and out-of-town merchants have been reducing their obligations. Collections are now very, very good in this market."

SEPTEMBER is also the opening of the season in the great grocery distributing trade, of which New York is the headquarters. In this line it was learned from Messrs. Francis H. Leggett & Co.: "The wholesale grocery trade, for which this is the opening of the busy season, is much more active now than at the opening last year. The number of buyers visiting the city and the number of orders coming by mail are encouraging, but it is too early to institute comparisons with former years that will be of value. The handling of imported goods is a large branch of the business of our house, and there has not been time, since the going into effect of the new tariff law, for our trade to become adjusted to the new rates of duty. The ending of the discussion on this subject has given a stimulus to trade. People do not care always so much about what they have to pay as they do about buying on a certainty; they hesitate to engage to pay 15 cents a pound for an article which, a little later, might be bought for 14½ cents. Hence the benefit to us of getting the tariff discussion out of the trade. We believe that the condition of business over the country is improving.

Mr. C. A. Moore, of Manning, Maxwell & Moore, extensively engaged in the machinery business, said of the situation: "While there are evidences of returning business activity, the improvement cannot be said to have reached our particular line. The machinery industry is about the first thing to feel the effects of a business depression, and the last to recover. The trade in articles of daily consumption responds most readily to fluctuations in business conditions; clothing is in demand, changing with the seasons, very much in the same volume, year by year; but important sales of machinery must await the starting of new enterprises, or considerable additions to old ones, involving the investment of new capital, and that, in turn, is dependent upon good business prospects and a settled feeling of confidence. Without doubt the business of manufacturing has been overdone in this country; at least some marked successes in this business induced many persons to go into it within recent years who ought never to have done so, and who met with disastrous results. Almost everything has been on a basis of too much inflation. The whole country was in the position of an individual living beyond his means, without realizing the fact, when the Baring failure occurred. Our business depression has not been confined to the United States, by any means, but local causes have contributed to it, and in the minds of many people bear the blame for the whole trouble. For more than a year the eyes of our people have been too much upon Washington, where both the Sherman-law repeal and the revision of the tariff occupied more time than was anticipated, during which period the people had their minds distracted from business, and industries came to a standstill. The end has been reached in this respect, however, and meanwhile a course of general liquidation has been in progress, and a gradual but slow revival of business may be expected as confidence is reëstablished."

Respecting the metal trade, Messrs. Bruce & Cook, who are large importers and dealers, say: "We are able to see a marked improvement in trade. Since the passage of the tariff bill there is apparent a more general confidence, and an increase can be reported in the number of inquiries for prices, particularly with regard to tin-plates. Houses in the trade were inundated, after the passage of the new bill, with telegrams and letters asking why the shipment of tin-plates was delayed. The answer made in such cases was that, the nearer October 1 (the date at which the reduced duty was to take effect) was approached, fewer boxes would be found in stock, duty paid, as houses holding plates in bond could not be expected, in advance of the reduction in duty, to withdraw them except for actual requirements. A good indication of gradual improvement in the metal trade is the satisfactory character of collections. Payments have never been more prompt than at the present. Dealers in the interior seem during the past year to have been putting their money into banks instead of into stocks. They are now in a good position, therefore, having light stocks, to create an active fall demand for all lines of metal products.''

THE volume of railroad traffic is a good barometer of business conditions, and the showing which has been made by the roads of late is both interesting and encouraging. In the following table a comparison is made between the total amount of the westbound freight (in tons) shipped from New York by all railways during the last twenty months and the amounts for periods of one year previous, together with columns showing increase or decrease :

MONTHS.	1893.	1892.	Increase.	Decrease.
January-June	783,057	772,317	1.4%	....
July	96,461	127,435	....	24.3%
August	103,756	144,297	....	28.1%
September	141,484	145,207	....	2.5%
October	106,469	127,235	....	16.3%
November	97,640	128,978	...	25.1%
December	85,591	130,766	....	34.5%
	1894.	1893.		
January	98,168	125,052	....	21.5%
February	91,713	116,007	....	20.9%
March	114,851	154,178	....	35.5%
April	106,385	147,571	....	27.9%
May	116,616	130,023	...	10.3%
June	120,635	110,387	9.3%	....
July	106,917	96,461	10.8%	....
August	125,000	103,756	20.5%	....

''There has been a marked improvement in business since the passage of the tariff bill,'' was the language of an official of the New York Central and Hudson River Railroad Company, ''and its effect will shortly be felt by all the railroads. I refer first of all to the large amounts of merchandise which have been sold lately in New York city and are now going into the channels of distribution. It is too early yet to make predictions about the eastbound freight. Crop reports are uncertain where we come to matters of detail, but there is no doubt that the crops are very heavy, though not so heavy as to depress prices and demoralize business in the west. Already the railroads are beginning to make a good showing of traffic as compared with last year, and I believe that a still better showing will result from the crop movement.''

THE collector of customs at the port of New York, the Hon.

James F. Kilbreth, in making a statement for The Engineering Magazine, said: "The indications visible in the operations of this office are of an improvement in business conditions. It is not a marked improvement—nothing in the nature of a 'boom'—but it is enough to give reason for hopefulness. The first indication was in the shape of greatly increased withdrawals of imports after the passage of the new tariff bill. Many of the goods affected had been in bond for some time, awaiting the expected going into effect of lower duties. But the fact of their withdrawal under any conditions is an evidence of a consumptive demand for goods, and that renewed activity exists in commercial circles. Another indication of greater business activity is to be found in the increased volume of imports—free and dutiable combined—during the short time that has elapsed since the enactment of the new tariff law. It is too early yet to predict the effect of the law upon the extent of the revenues as compared with the receipts in previous years, though we are hoping to see an increase."

The extent of building operations in New York, which indicate pretty fairly the conditions of business at different seasons, may best be studied by consulting the books of the municipal department of buildings, in which are recorded the estimated values of the proposed buildings, at the time that building permits are asked for. In a study of these figures by months for three years past it will be found that the period of greatest activity was during the spring of 1893. After the beginning of the financial panic in that year the figures for each month fell far below the corresponding month of the preceding year. The same condition prevailed during the earlier months of 1894, but, as will be seen from the annexed table, there has been an improvement of late. The estimated cost of buildings for which permits were granted in July, 1894, exceeded the figures for the same month in preceding years.

ESTIMATED COST OF BUILDINGS UNDER PERMITS GRANTED IN NEW YORK CITY.

	1891.	1892.	1893.
September	$3,631,558	$3,159,736	$1,195,195
October	4,488,160	3,801,283	1,527,905
November	3,644,391	3,271,912	2,184,904
December	5,422,928	3,610,017	1,582,089
	1892.	1893.	1894.
January	$3,053,465	$4,684,849	$3,268,848
February	5,378,709	5,042,303	2,956,958
March	8,817,725	7,144,080	4,253,614
April	11,204,540	9,810,072	6,167,558
May	7,004,070	14,705,068	8,613,002
June	8,049,740	7,018,767	5,456,909
July	4,630,947	3,820,710	5,282,203
August	4,700,148	3,085,343	3,768,577

In an editorial review of the business situation on September 17, the New York *Evening Post*, which ranks as a conservative and very high authority upon commercial affairs, had this to say:

> Whatever claims may be made as to causes, of the fact of a revival of trade there is now no doubt. It has not come with a rush, with the exception of certain lines of business immediately affected by change of duties, but it is coming gently and gradually, as men like to see the rain begin after a time of drought. The barometers generally watched with most care are three: The clearing-house returns, the bank loans, and the blast furnaces. The first indicate in a general way the amount of the exchanges of goods that are taking place. The loans made by the banks indicate the existence of a demand by solvent borrowers which would not exist unless they saw how they could make a profitable use of borrowed money. The production of iron is significant because that metal is the basis of all industry.
>
> If we glance at the recent figures showing the amount of bank clearings we find a rate of increase quite as rapid as is to be wished. The clearings during the month of August were in 1894, 3,564 millions of dollars, against 3,376 in August last year. For the week ending September 1 they were 767, while last year they were 700. For the next week the figures were respectively 809 and 731; and for the week ending September 15 they were 882 and 803. There has thus been a gain of about 10 per cent. during the last few weeks, with indications of a continued increase. No more rapid rate of increase than this, we incline to think, could be regarded as altogether healthy.
>
> Turning to the returns of the New York city banks, we see that during the last week of August the loans increased very slightly over the amount of the previous week, but very greatly over the corresponding week of 1893. The figures for 1893 were $400,000,000, but for 1894 they were about $490,000,000. The following week showed again but a slight advance, although far in excess of last year, but the week ending September 15 showed an advance of over $3,000,000; an increase of over $100,000,000 beyond the amount last year, and very largely in excess of the loans of 1892.
>
> We confess that we regard the extremely rapid increase in the production of pig-iron during the last few weeks with some anxiety. In the region west of the Alleghany mountains and north of the Ohio river, the production appears to be nearly as great as it has ever been. The weekly capacity of all the furnaces in blast on September 1 was reported to be 151,000 gross tons, and this is, we believe, within 25,000 tons of the maximum production recorded. We must go back until June, 1893, before this production is equalled. But what is startling is the contrast with the earlier months of this year, and especially of this summer. During no previous week has the capacity of the furnaces in blast exceeded 127,000, and on the 1st of June the number in blast was but 88, with a capacity of only 62,517 tons. The number has now risen to 171, and the capacity, as we have seen, to 151,113, as compared with 86,000 tons July 1, and 115,356 on the first of August. The stocks on hand, withal, are reported to have decreased. Since there appears to have been little change in prices, we must suppose that present rates are sufficient to induce increased production. If this be true, the whole industrial world will feel the advantage of the cheapness of iron, and this will of itself have an important influence upon general prosperity.

THE COST OF LIVING IN BRITAIN AND THE UNITED STATES.*

By Andrew Carnegie.

IF asked upon what subject the general opinion of Britons was farthest astray regarding the United States, one would not be far wrong in answering, As to the comparative cost of living in the old land and in the new.

It will probably prove a work of time and of some difficulty to remove an impression so generally entertained as that which finds expression in the words recently spoken by a high English authority—viz., that "the United States would be a perfect El Dorado for the workingman, if it were not for the high cost of living."

It is easy to show how this impression has arisen. The Briton arrives in New York and hires a carriage, which has been waiting for the steamer several hours; he is charged an exorbitant price; he orders a bottle of imported wine, and finds it much dearer than at home; he learns that the cost of clothing made to order from imported material is also much dearer: and these things strike him deeply, because they are the first impressions received. When asked upon his return upon what data he has reached the conclusion that the cost of living is dearer in the United States than at home, he invariably gives these three items, and stops there. But these do not constitute the chief sources of expenditure even to travelers, much less to residents. Asked how he found the cost of living at hotels, he remembers that it costs less in the Republic, where the charge in the best hotels is from fourteen to eighteen shillings per day, the latter being the extreme rate in New York. For this he has a comfortable room and all meals—breakfast, luncheon, dinner and supper. He also remembers that he could scarcely have such a dinner at the Metropole in London for the entire eighteen shillings, which pay for all meals and a room at the Windsor Hotel, New York. Asked how he found the cost of traveling, he figures a little and finds that it is just a little more than one-half, first-class, even including sleeping cars. The cheaper cost of railway travel per mile, and of hotels, is not nearly offset by the extra cost of cabs and foreign wines. The visitor buys no clothing, and if wise will follow the American example and use the hotel omnibuses or electric cars, and rarely, if, ever, use cabs, which are not an American institution. If the visitor wishes, however, to hire a carriage and pair by the day, week, or month, or for theater or reception, he is provided in New York at prices not beyond those charged in London—forty to fifty pounds per month, according to circumstances, and twelve shillings per night for a brougham ; for an afternoon in the park the charge for a carriage and pair is even less in New York. It is undoubtedly a fact that the cost of travel, including all necessary expenditures per day, over equal distances, is much dearer in Britain than in America. But this fact affects only the few travelers, usually persons of means, and is of little moment. The great point is, as to the comparative cost of living to the mass of people, the wage-earning class of the two countries.

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Let us calmly consider this. The income of the mass of workingmen, skilled and unskilled, is from £60 to £120 sterling per year. Now we must first learn the percentage of these earnings spent for each of the principal necessaries of life. According to the Bureau of Labor statistics of Massachusetts, the highest authority, these in England and America are as follows :

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Income, $300 (£60) to $450 (£90) per year.			Income, $450 (£90) to $600 (£120) per year.		
Items.	American.	English.	Items.	American.	English.
Subsistence.......	64	81	Subsistence......	63	78.75
Clothing.........	7	7	Clothing........	10.50	10.50
Rent............	20	13	Rent...........	15.50	10.37
Fuel.............	6	6	Fuel.......... .	6	6
Sundries..........	3	3	Sundries........	5	5
Total.........	100	110	Total.........	100.00	110.62

This shows the increased cost of articles in Britain to be 10½ per cent. But prices in the United States have fallen since this table was made, much more than in Britain. In Charles Booth's valuable work, " Labor and Life of the People " (British), he gives the amount spent for food alone as from 60 to 50 per cent., according to the family revenues. In the broader term " subsistence," not only food, but all that enters the mouth is embraced. Thus " subsistence " is the chief item of cost for the workingman's family. It ranges from 64 per cent. in America to 81 in England. The reason for this difference is obvious. Of course, all food is cheaper in the United States than in Britain. The former exports it to the latter. Tobacco is very much cheaper. America grows tobacco, and only taxes it 3*d.* per pound, as against a 3*s.* 6*d.* tax in the Monarchy—fourteen times as great. Of course, what he drinks is cheaper. The duty on whisky is 20*d.* per gallon, as against 11*s.*—six times greater—in Britain, and it is made more cheaply in

Kentucky than in Ireland or Scotland. Upon beer the taxation is 4*s.* and 7*s.* respectively per barrel. Tea and coffee are free of duty to the American; they are taxed to the Briton. Sugar (raw) is free in both lands, but in the Republic there is a slight tax upon foreign refined. When the masses in Britain realize how heavily they are taxed compared with the workers of the United States, there will probably be a prompt demand for reductions upon articles embraced in the term "Subsistence," and especially for a free breakfast-table.

The low cost of what goes into the mouths of the people throughout the United States would surprise any British investigator who made it a study, but the cost of living in the forty-four States, occupying a continent, is to be determined not only in New York city, and in the cities and towns upon the Atlantic sea-coast, to which products of the great West have to be transported, but also by taking into account cost at the center of population, which is now near Indianapolis, Indiana, midway between Chicago and St. Louis, eight hundred miles inland from New York.

Having dealt, with say, three-fourths of the total expenditure of the workingman's family—namely, that for "subsistence"—and found that it cannot be otherwise than that the articles consumed must be cheaper in Indianapolis than in Manchester, by at least the cost of rail and ocean transport and merchant's profits, we come to the second item, which is "rent," consuming 20 per cent. of the earnings of the family in America and 13 in England. The British workman lives in a smaller house. The better class of American, as a rule, has three or four rooms; the Briton two. Rent is undoubtedly much higher in the newer land.

The next item in importance is "clothing," which represents 7 per cent. of the expenditure in the United States, and exactly the same percentage in Britain. This will, no doubt surprise most readers until the reason is given, which is, that while clothing made from the finest imported cloth is very much dearer in America than in Britain where the cloth is produced, clothing made from the American cloth is very cheap indeed and serviceable. It is, however, coarse and harsh, and not so agreeable to wear—harsher even than the Scotch cheviot. But the mass of the people wear it as they wear woolen underclothing of the same kind. Hence the masses are not affected by the duties placed upon the fine woolens, which are imported only for the rich few I have before me advertisements in the American papers of complete suits of ready-made clothing ranging from two to three pounds—just the cost in Britain.

Here is a true story bearing upon this subject. A well-known member of Parliament, addressing his constituents in the Midlands some time ago, told them that living for the workingman was much higher in America than in Britain, and said that the cost of clothing was three times as great. A copy of this speech was sent to his friend, one of the best-known men in the United States, whom the speaker was in the habit of visiting. A short time after, he visited his friend in the Republic, accompanied by his wife. One morning the host appeared at breakfast in a new suit which elicited general admiration, the English lady stating that it was "much smarter than the suit worn by her husband." The host then asked his visitor what he supposed the suit cost him; to which the unwary Briton replied, "Well, the suit I am now wearing cost me £7, and I suppose yours, in this terribly protected country, must have cost £12." This was his opinion after having examined the suit. "Well," said his host, "I paid just $4.50 (18*s.*) for this suit, and I wish you to take it back to England and show it to your constituents and tell them this." Amidst much laughter, this was declined. His host had seen in the village a traveling van from Boston, from which ready-made clothing was being sold, and asked the vender if he had a suit to fit him; to which he replied "Yes, and if you take a suit you can have it at wholesale price. Retail price is $6 (24*s*)." "Very good: send it to the house." It was promptly sent, with the result stated. Of course it was American material, not as smooth or as fine as the cloth worn by the honorable member; nevertheless, a good, smart suit. The price, however, was so very low that it is fair to record that I should hesitate to say that it was likely to prove serviceable. For £3, however, serviceable suits are easily obtained.

When we look at the amount of the extra fine woolen goods imported by the United States, we see how trifling it is, compared with the total consumption of wool. In 1890 the value of home woolen manufactures was $338,000,000—say sixty-eight millions sterling. The import of the high-priced fine foreign woolens was only $35,500,000—seven and a tenth millions sterling. It is safe to say that the value per yard of the foreign was double that of the domestic; hence the number of yards of foreign woolens used was not much beyond 5 per cent. of the amount consumed, and all by the few wealthy people, who alone use the high-priced foreign articles.

We have the same result with cotton manufactures, the value of the home American product being $268,000,000—fifty-four millions sterling; the amount imported being $28,000,000, not six millions sterling, which represents not quite 5 per cent. of the total consumption, assuming double value per yard for the foreign. The amount of cotton goods used by a workingman's family is considerable.

In regard to silks we have the following figures for the year 1890: product of American mills, $69,000,000—thirteen millions eight hundred thousand sterling; the imported manufactured silk, $31,-000,000—six millions two hundred thousand sterling. It may safely be assumed that the value of silks imported, per yard, was double that of the domestic, so that more than four yards of American silk were consumed to one of foreign.

While upon the subject of clothing I may note two facts within my own experience. An American family, having numerous servants, resides part of each year in Britain. The servants pass to and fro, and thus have opportunities to purchase their clothing, boots and shoes, etc., either in the one land or in the other. The men-servants continue to purchase clothing in the old land. The women-servants find they can purchase to better advantage in New York Boots and shoes are purchased by all in New York.

The second instance: A Scotch-American family with five children spend part of almost every year in Scotland. The able, thrifty mother formerly took the opportunity to supply her own and the children's clothing, etc., in Glasgow. Upon recent visits she has purchased nothing upon this side, and I heard her give as a reason, that she found that clothing for herself, and especially for her children, could now be purchased better and cheaper in New York than in Glasgow.

The well-known Free-Trade or tariff-reform writer, Mr. Schoenhof, was deputed by the State Department to report upon cost in the United States and Britain, and reported as follows some years ago:—

"So far as clothing and dry goods in general are concerned, I find that cotton goods are fully as cheap in the United States as here. Shirtings and sheetings, if anything, are superior in quality for the same money with us, so far as I can judge from the articles exposed for sale in the retail stores. Articles for underwear for women, made of muslin, are far superior in workmanship and finish, and cheaper in price, in the United States. Nor can I find that men's shirts, when chiefly of cotton, are any cheaper here. Of boots and shoes, if factory made, the same may be said. In workmanship and finish I find corresponding articles of the wholesale process of manufacture superior in the United States. This is true of clothing as well as of cuffs, collars, and like articles."

Prices of articles other than agricultural have fallen in the United States much more than in Britain since Mr. Schoenhof reported. This fall has been so great as to put the price of Bessemer, pig-iron, and steel billets at Pittsburgh lower than at Middlesborough: to enable American carpets to be sold in Britain; to tempt the leading American shipbuilders to ask permission to tender for some of the new British war-ships; the Clyde Trustees to purchase their new and powerful dredgers in New York. It has also enabled the American manufacturer of agricultural implements to reach the British market, and the quarrymen to send granite from Maine to Aberdeen.

The next item which figures in the expenses of the workingman's family is "fuel." Speaking generally, this is much cheaper in the United States than in Britain. If we compare New York and London, New York receives anthracite coal as cheaply as London receives bituminous coal. The former will, at least, give double service, and it is said to yield three times as much. In the center of population in the United States the cost of coal does not exceed 8*s*. per ton. In the great western Pennsylvania and Ohio districts it is not more than 6*s*. The American has to use more coal in winter owing to the severer cold, and has more fires going in his larger house. Experts have found that the percentage of their earnings spent by the American and Briton on fuel is equal—viz., 6 per cent.

It has been common in Britain to attribute the supposed higher cost of living in the United States to the effect of the tariff. Now a little consideration will show that this impression is not well founded. The principal highly-taxed articles under the McKinley Bill are five: First, the extra fine silks of France; second, the fine woolens and linens of Britain; third, the extra fine linens of Germany and France; fourth, the high-priced wines of France; and fifth, Havana tobacco and cigars. The duties on all these are very high. Woolens 60 per cent. of their value, silks even higher, champagnes 32*s*. per dozen, etc., etc. This is our "Democratic" Budget. There is not a workingman in America who uses any of these articles. It is considered good policy thus to tax heavily the luxuries of the rich, and admit free the tea and coffee and raw sugar used by the masses. It is not probable that this policy will be reversed, or even greatly modified, however much talk there may be of tariff reform. Indeed, the wholesome tendency now seen in Britain to lay the burden of taxation upon the wealthy few who can best afford to bear it is not less strongly marked in the Republic. The necessaries of life used by the workers will probably remain duty free in the Republic and soon become free in the Monarchy, and the luxuries of the rich will continue to be taxed more and more in both lands.

The position of the supposed unfortunate farmer of the United States used to be cited, and the point made, that owing to the tax upon machinery he had to pay more for his agricultural implements than was otherwise necessary, but as the American has now the command of the world for agricultural machinery, and exports it, the farmer is no longer interested in the tax upon foreign machinery.

The appearance of the United States as an exporting country of manufactured articles, owing to reduced costs, is one of the notable events of recent years. Here are a few items: In the year 1893 agricultural implements were exported to many parts of the world to the extent of nearly £1,000,000; manufactures of copper to the extent of £900,000; cotton manufactures, £2,400,000; iron and steel, and manufactures of these, £6,000,000; carriages, cars, etc., more than £500,000; wood, and manufactures of wood, over £5,000,000 sterling, American furniture being now largely exported.

In the year 1892 the Republic exported as much iron and steel, and manufactures thereof, as she imported—viz., $28,000,000 worth in both cases—five and three-quarter millions sterling.

It is notable that musical instruments, valued at £360,000, were exported; glass and glass ware to the extent of £1,600,000; leather and manufactures of leather, over £2,000,000; paper and manufactures of paper, to the extent of over £300,000 (some English journals are now printed upon American paper); instruments for scientific purposes, £260,000; clocks and watches, over £200,000.

The export of manufactured articles rapidly increases year after year, but, unlike that of Britain, must ever remain totally insignificant as compared with the value of the total home production of manufactures, which was no less in 1890 than £1,750,000,000. The value of British manufactures in 1888 was not quite half as great, being £820,000,000.

The prosperity of a new continent like the United States is not to be gaged by its foreign but by its home commerce. As the new land more and more supplies its own wants, her foreign commerce must relatively decline; more of the cotton grown, for instance, being manufactured at home, and less going abroad, and so with all the natural products, as also with many articles now imported, which will be made at home.

In view of the facts here noted, and also the obvious fact, that subsistence must be cheaper in one country than in the other, and that this embraces three-fourths of the total cost of the necessaries of life for a workingman's family, how are we to account for the general impression still lingering in Britain, that the cost of living is higher in the United States? Simply for this reason: that while it is true that a pound sterling in the United States to-day will purchase more of the necessaries of life for the mass of the people than it will in Britain, and while the American workman has great advantages over his fellow British workman in consequence, still it does not follow by any means that the American workman lives as cheaply as the Briton—far from it. He has much higher wages. The report of the Senate Committee recently made shows that the average percentage of American wages obtained by the British workman is only 56½ per cent.—not much more than one half—the principal handicrafts being made the basis of comparison.* Having higher revenues, the American is not content to live without what would be considered luxuries in any of the old countries of Europe. He earns more and he spends more. Therefore, in one sense it is true that the cost of living as the American workman lives is greater than that of the Briton as he lives. But it is none the less true that this arises from the fact that he lives in a different manner. For those similar things which are absolutely necessary the cost is much less in the newer land.

The American workman and his family can live very cheaply indeed if so inclined, or they can spend inordinately just as easily as in any other country. We find this proven by the expenditures of foreign workmen, especially Hungarians and Italians, who have in recent years emigrated to the United States in great numbers. The usual price paid by these foreigners to the keeper of the boarding-house is ten cents (5*d.*) per day for food. They usually sleep in wooden huts erected for them by their employers. In times of unexampled industrial depression, like the present, the ability of the masses of the people of the United States to live cheaply and yet comfortably is of the greatest moment, for it has shielded them from much acute suffering which would otherwise have resulted from the lack of work—an experience new to this generation of Americans, and likely soon to pass away, unless the faith of capital in the maintenance of the gold standard be again shaken. An equivocal note upon this subject, struck by the Secretary of the Treasury May last year, paralyzed the business of the country for the time—and recovery has been retarded by impending new legislation affecting duties upon imports.

Whether America be the El Dorado of the workingman or not, depends upon the workman himself. He and his family can now live for less than a family in Britain, if they will live as frugally. They are in the position of the old Scotchwoman I knew, who, being asked if she could live upon a certain sum as an annuity, replied, "Ou ay, I could live on half o't, but I could spend dooble." That is to say, a pound sterling in the new land, judiciously spent for the necessaries of life by the workingman and his family, will to-day purchase more of these in the new than in the old home of our race—a fact probably fraught with far-reaching consequences upon both sides of the Atlantic in the not distant future.

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* But it is to be noted that since this report was made three years ago, wages have fallen in the United States, probably as much as 10 per cent., as compared with wages in Britain. This fall, however, is likely to prove temporary, as until the panic of July last year the tendency was to even higher wages than existed at the date of the report.

THE INDUSTRIAL DEVELOPMENT OF CHILE.

By Courtenay De Kalb.

THE republic of Chile is entering a new period of development, under the impulse of a sudden awakening of interest in technical industries. Conditions at home and abroad have combined to surround her with difficulties which will be lessened if not removed by providing remunerative employment for her people. Of a total population of 3,300,000 no less than 60 per cent. is classed as urban, and only a small proportion of this large urban population consists of artisans, and few of these are possessed of that knowledge of their trades which would rank them among "skilled workmen" as that term is understood in the United States and Europe.

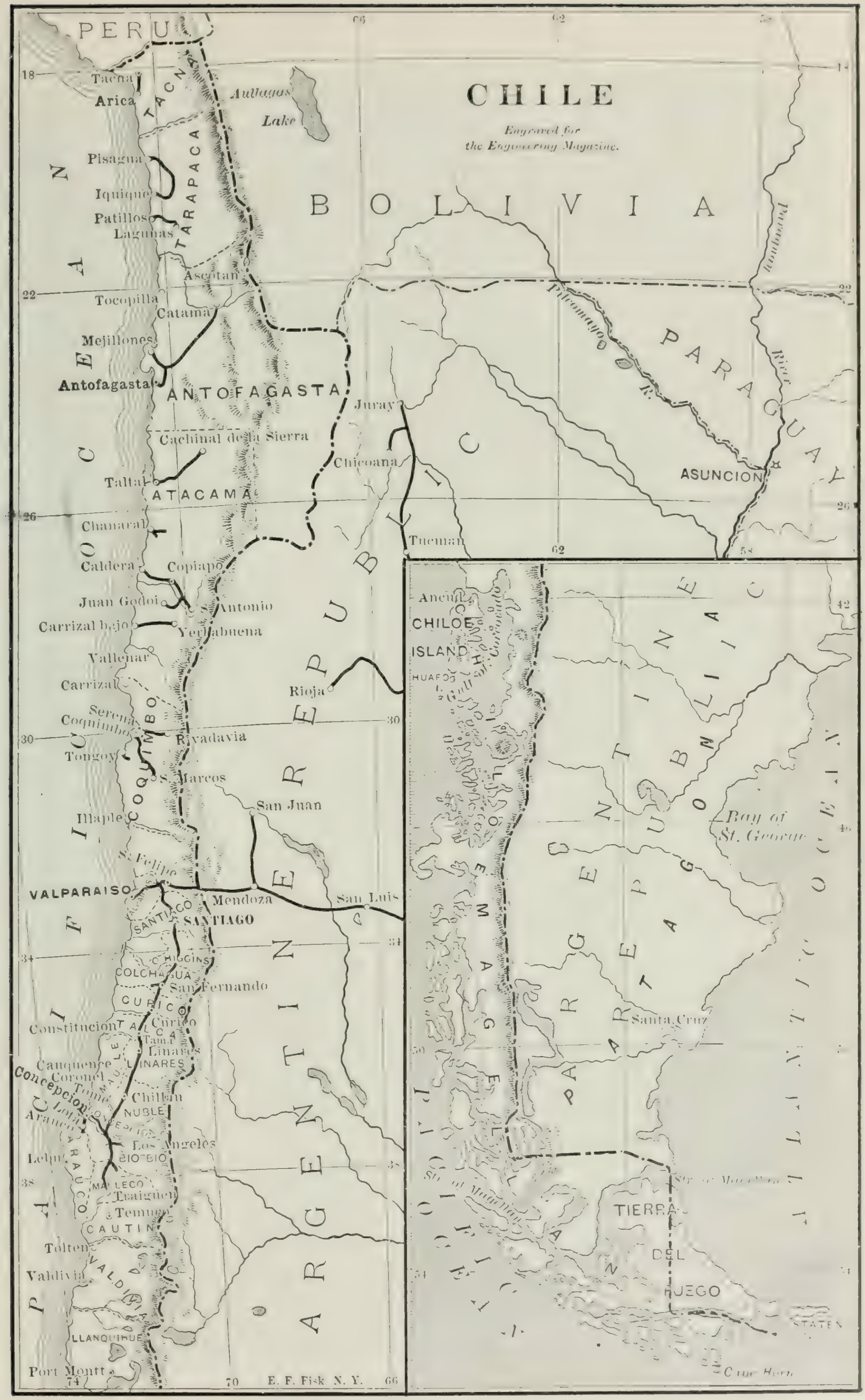
When it is considered that this tendency to urban life is so pronounced that considerably more than a million people live in cities having populations of more than 30,000, and that there are thirty other cities with a population exceeding 10,000 each, we see at once that Chile is confronted by a very grave problem, indeed. Evidences of social discontent are abundant, although not manifested in ways familiar to those who live in countries where the mechanical arts have attained importance. There is nothing to strike for and nobody to strike against. In short, there is no employment to be had for the great multitude of idle hands. For months after the recent civil war outbreaks of mob violence and highway robbery were so common that many of the Chileans themselves felt that they were "sleeping upon a volcano." That they were not actually sleeping is shown by the fact, which merits admiration, that the newly-constituted authorities succeeded in choking every vent of the threatening social volcano which lay beneath them, and which lies beneath them to-day.

Still more admirable is the wisdom and foresight of that policy, favoring by every legitimate means an improvement of the industrial condition of the country, which is so conspicuous a characteristic of the government under the present administration. This is not saying that those in power have proved themselves wise in all their acts, that they have not made many blunders, nor that they have not at times flown in the face of their declared principles. But they have had many hardships to contend against. They assumed the responsibilities of government at a period of paralysis resulting from a disastrous war, with a national debt amounting to nearly $55,000,000, with exchange rapidly declining because of the depression in silver and from want of confidence, and with diminishing importations lessening the revenues. In spite of all this the government has boldly committed itself to a policy of protection, and of subsidies to special enterprises: has appropriated money for a mining and metallurgical exhibition, and for other purposes the returns from which are entirely prospective.

There is no doubt that the principle of protective tariffs has taken a firm hold upon the minds of the Chileans. Protectionist clubs have been formed, the Society for the Promotion of Manufacturing has lent its powerful influence to the cause, the Union of Artisans, the Society for the Protection of Mechanic Arts of Valparaiso, and other similar organizations have taken the field, and the most important newspapers of the country have followed their lead. Fortunately there is already a fair nucleus around which to build up industries of importance. There are no less than 100 soap-factories in Chile; a native bottle-factory has been in operation at Lota for several years; and now the manufacture of illuminated glass has been undertaken. Woolen-mills are established near Santiago and at Tomé; a tobacco-factory in Valparaiso is running with a force of 120 employés; and there are other plants for the manufacture of cardboard, paper, bricks, earthenware pipes, enamelled-iron ware, cement, and chemicals. The only nail-factory in South America is in operation at Chillan. There is a small sugar-refinery at Viña del Mar, and sugar-mills are found on several estates. Almost all the blasting-powder used in Chile is produced in native factories employing the nitrate of soda of the country, and every important *hacienda* in the agricultural districts possesses a flour-mill as part of its equipment. Many of the latter are of the modern roller type. Ice-factories at Santiago and Valparaiso have proved successful, one in connection with the brewery and factory for carbonated beverages in Santiago having three machines of the Raydt and the R. Pictet systems, with a total capacity of two-and-a-half tons an hour.

In addition to these all the chief centers, such as Santiago, Valparaiso, Caldera, and Carrizal, possess large workshops, foundries, machine-shops, and saw-mills. In the workshops in Valparaiso locomotives, steam-pumps, Root blowers, and other machines have been made from iron and steel imported from the United States and Europe. In consequence of this the Society for the Protection of Mechanic Arts in that city has demanded that in future all locomotives and cars for the Chilean government railroads shall be of home construction.

A noteworthy manifestation of the growing sentiment in favor of a high protective tariff was made at the session of the Commission of Industrial Instruction in 1893, when representatives of all the principal trades insisted that not only was competition with imported goods im-


CHILE
Engraved for the Engineering Magazine.
PERU
BOLIVIA
PARAGUAY
ARGENTINE REPUBLIC
PACIFIC OCEAN
ATLANTIC OCEAN
Aullagas Lake
Tacna
Arica
TACNA
TARAPACA
Pisagua
Iquique
Patillos
Lagunas
Ascotan
Tocopilla
Catama
Mejillones
Antofagasta
ANTOFAGASTA
Cachinal de la Sierra
Taltal
ATACAMA
Chanaral
Caldera
Copiapo
Juan Godoi
S. Antonio
Carrizal bajo
Yerbabuena
Vallenar
Carrizal
Serena
Coquimbo
COQUIMBO
Rivadavia
Tongoy
S. Marcos
Illapel
S. Felipe
VALPARAISO
SANTIAGO
Mendoza
San Juan
San Luis
Rioja
Juray
Chicoana
Tucuman
ASUNCION
Pilcomayo R.
Paraguay River
O'HIGGINS
COLCHAGUA
San Fernando
CURICO
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Linares
LINARES
MAULE
Cauquenes
Coronel
Tome
Concepcion
Lota
Arauco
Chillan
NUBLE
CONCEPCION
Los Angeles
BIO-BIO
Lebu
ARAUCO
MALLECO
Traiguen
Temuco
CAUTIN
Tolten
Valdivia
VALDIVIA
LLANQUIHUE
Port Montt
Ancud
CHILOE ISLAND
HUAFO
Corcovado
Golfo de Penas
MAGELLANES
PATAGONIA
Bay of St. George
Santa Cruz
Str. of Magellan
TIERRA DEL FUEGO
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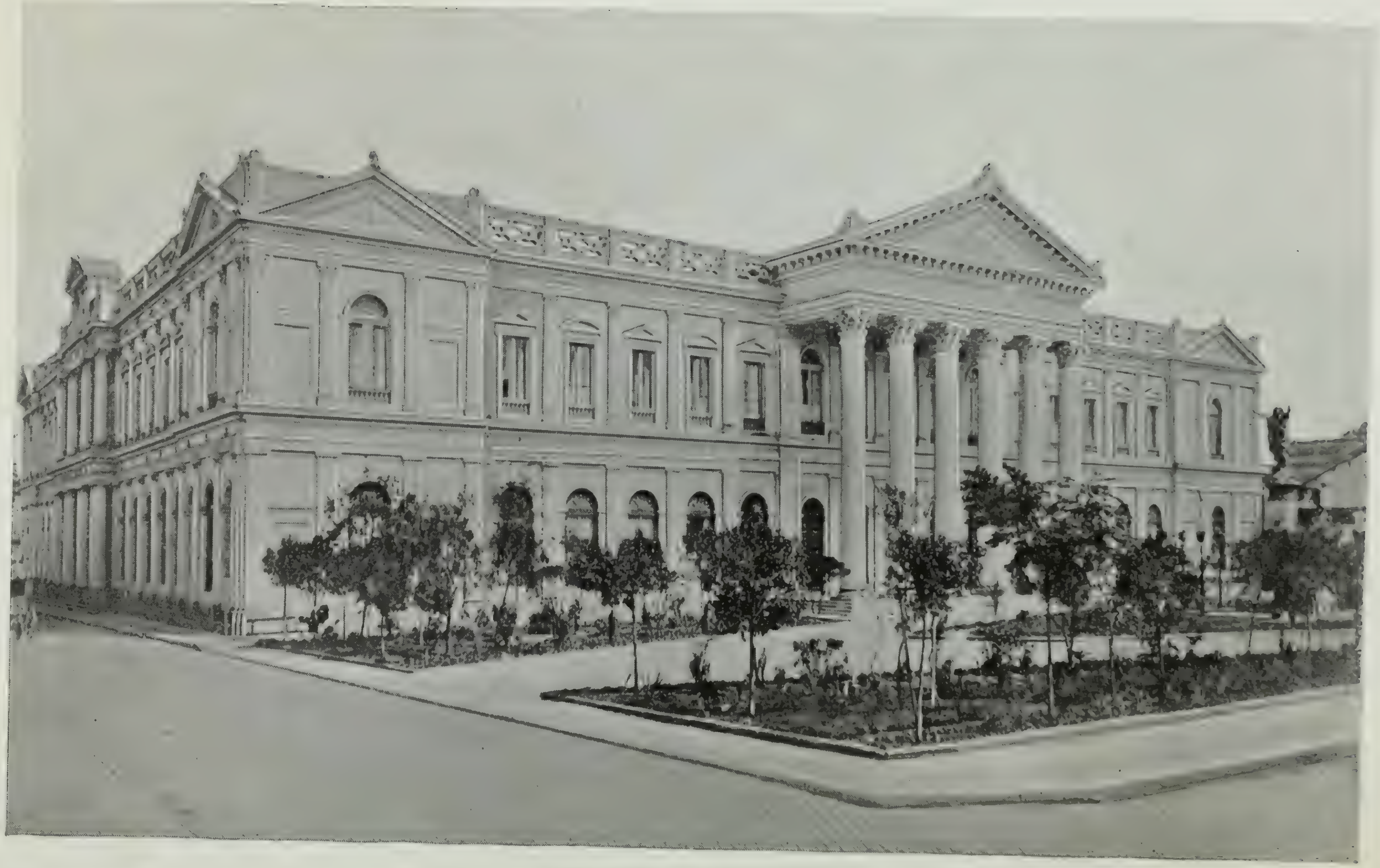


THE CAPITOL AT SANTIAGO,

MUNICIPAL BUILDING IN SANTIAGO.

possible under the existing tariff, but that, under the prevailing conditions, there was lacking that stimulus which was necessary to call into existence a sufficient number of skilled workmen to meet the local demand for repairs and occasional jobs. For example, workers in tinplate are entirely unfamiliar with the use of modern machinery and tools. The same is true of the cabinet-makers, and in all branches of industry it is almost impossible to find master workmen competent to serve as foremen. The establishment of night-schools for manual-training was strongly advocated by all, but it was pointed out that, while these would be certain to enroll large numbers of students, both young and old, if there should be some certainty of promotion of industry by protection, the opportunity would just as certainly be neglected if no such inducement of permanent employment were held out.

As an example of the effect of one such training-school, limited to engraving, electrotyping, and photo-engraving, the director, Señor Lebe, reported that the average attendance numbered forty-eight, but the demand for men in this trade was so great that almost all the students left before completing their course to accept positions offered. The result of these deliberations was to approve a plan for such a school, absorbing that of engraving, and adding to it instruction, with the aid of suitable plants, in decorative painting, bookbinding, tinsmithing, and tailoring, to which wood-working and the manufacture of all kinds of leather goods are to be added as soon as the funds permit. There is already in existence an Agricultural Institute at Santiago, with schools of practical agriculture in other portions of Chile, and a School of Arts and Trades at Santiago has acquired a high standing, and is capable of turning out complicated machinery and appliances for railroad-work, steamships, and naval vessels. A valuable technical library constitutes part of the equipment of this school, and, owing to complaints presented by labor organizations, the government is proposing to have the more important foreign text-books translated into Spanish for the benefit of the workmen of the country. The National Society of Mines and the Society for the Promotion of Manufactures have both done excellent service through their monthly bulletins in disseminating the best current technical literature, and the latter society has been maintaining a night-school of machine-design and management of motive power.

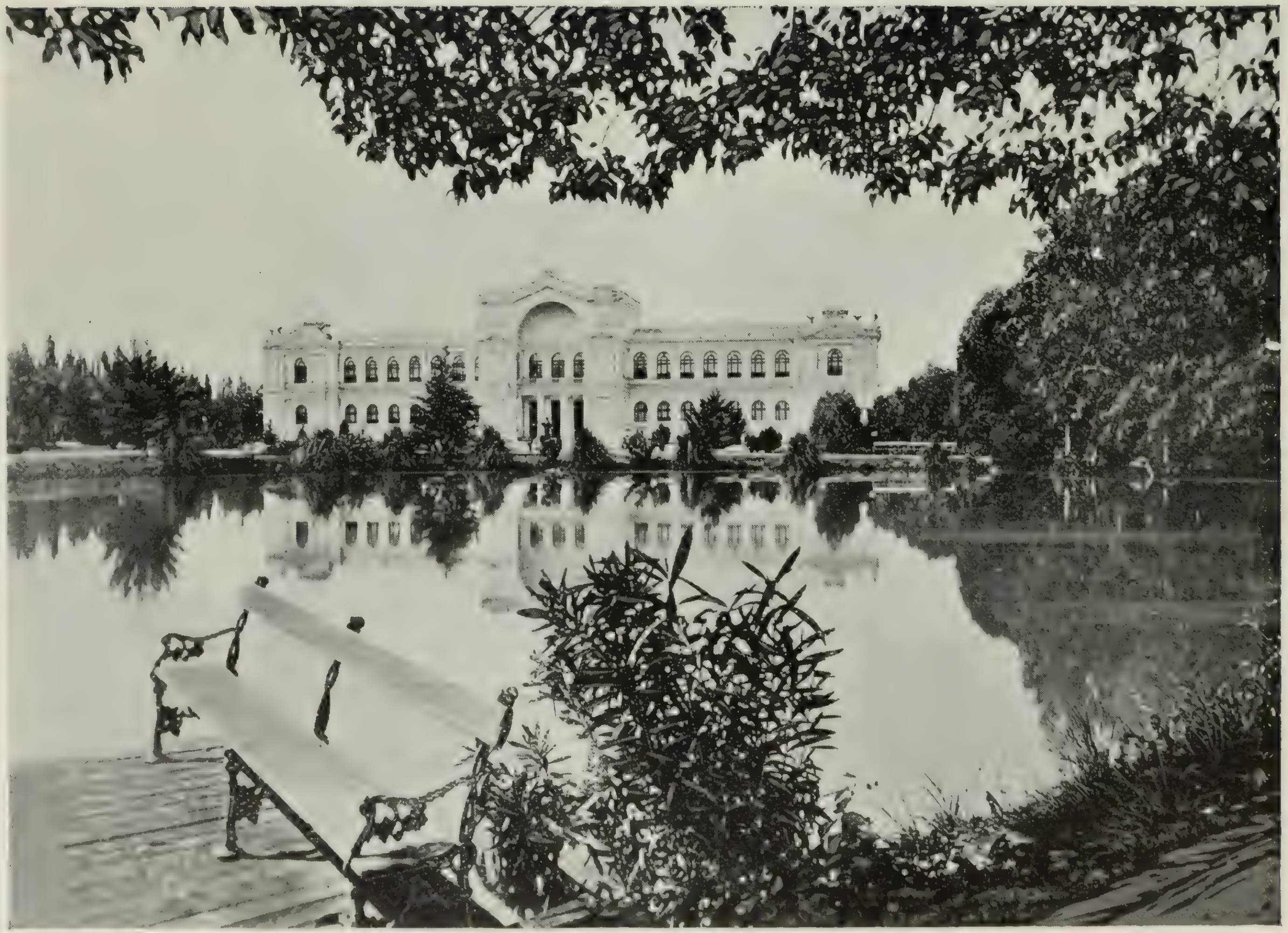
There is a considerable demand for skilled labor in the gas, electric-light, and electric-railway plants which are becoming very numerous in Chile. There are gas and electric-light installations in no less than twenty-five cities. In the gas-works at Santiago are 288 retorts with a capacity of 1,525,000 cubic feet during twenty-four hours. Three gasometers are now in service with a total capacity of 533,960

THE EXCHANGE, SANTIAGO.

cubic feet, and a fourth is being built to contain 457,680 cubic feet. The consumption of gas in Santiago is still very low, however, not exceeding 1500 cubic feet per capita per anuum.

Sixty per cent. of the coal used in gas-making in Chile comes from Australia, the remainder being from the native lignite-mines, excepting a small quantity of cannel coal from England employed to augment the illuminating power of the gas. Coal exists in Chile in the vicinity of Concepcion, in the province of Bio-Bio, and in Lota, Coronel, Arauco, Huena-Piden, and Lebu. Deposits have also been discovered in Valdivia, in the islands of Chiloe and Haufo, and in the straits of Magellan on the northeast portion of King William's Land. The mines of Bio-Bio are near the sea, and the coal is transported by steam- and sail-boats to the northern ports. The price of native coal varies from 10 to 15 pesos per ton, while English coal commands from 2 to 3 pesos more. The native coal is used for general metallurgical work, for gas-making, and quite largely for steamships. The production of Chilean lignites does not at present exceed 600,000 tons a year, but it is steadily increasing. The following analyses of two sam-

AGRICULTURAL COLLEGE, SANTIAGO.



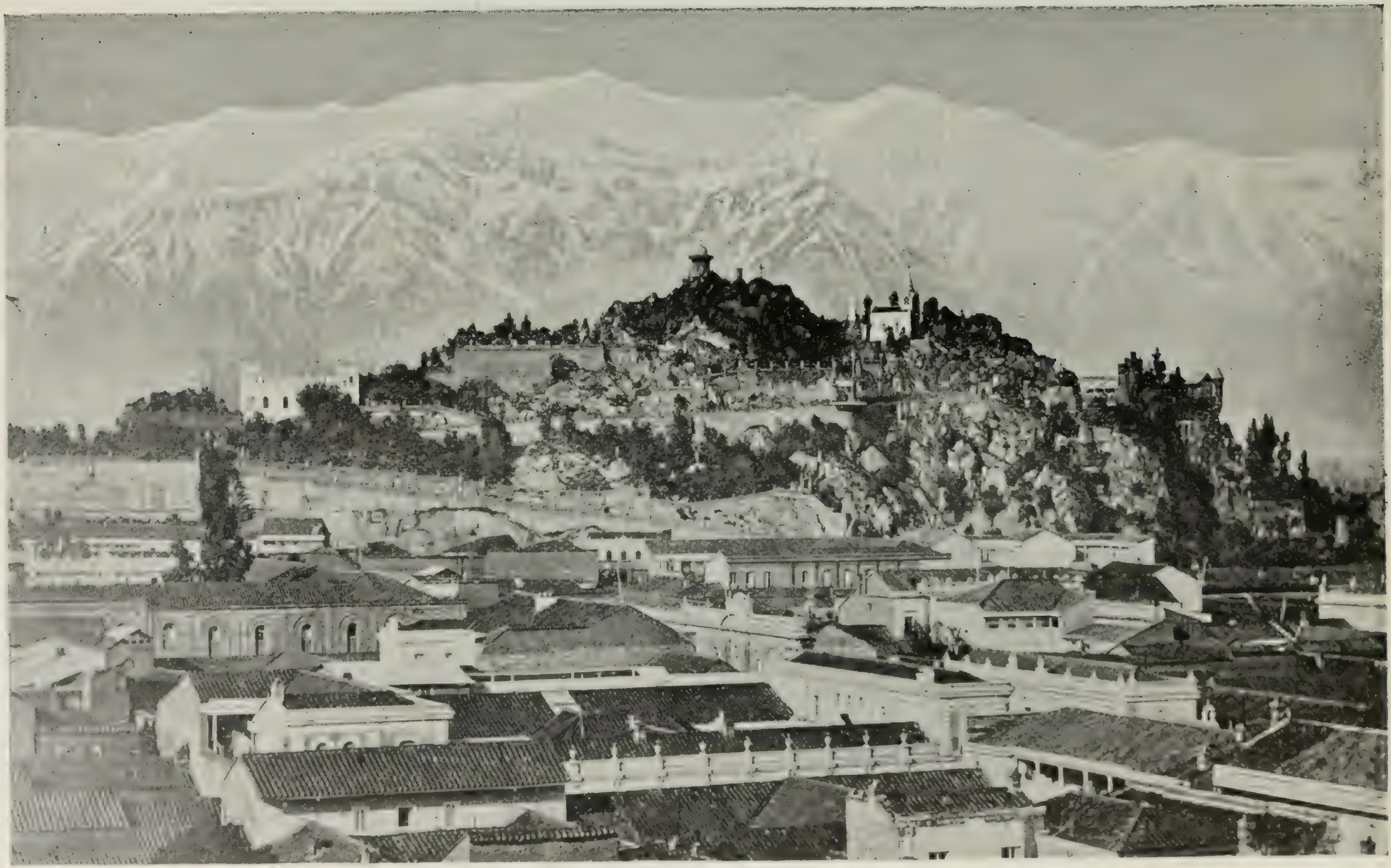
PALACE OF THE MINING EXHIBITION, SANTIAGO.

THE PASAGE BULNES (ARCADE)—SANTIAGO.

ples of brown lignite from Lota are fairly representative of the quality of that now in the market.

	I.	II.
Volatile Matter, percentage	40.8	40.2
Fixed Carbon	48.2	53.2
Water	4.8	5.0
Ash	6.2	1.6
Total	100.0	100.0

Sulphur is present in the proportion of from 0.02 to 0.1 per cent. It is noticeable that the sulphur content of these lignites is low in the



A VIEW OF SANTIAGO, WITH SANTA LUCIA.

more northerly mines, and increases toward the south. Exception must be made, however, of the deposits of Chiloe, whose composition closely resembles that of peat. The beds now being worked vary from 1 foot 11 inches to 5 feet in thickness. Some of the mines are worked to considerable distances below the level of the sea. The Chambique shaft, which penetrates the strongest vein now known in Chile, is 328 feet deep, while the Santa Amalia shaft is 1082 feet deep.

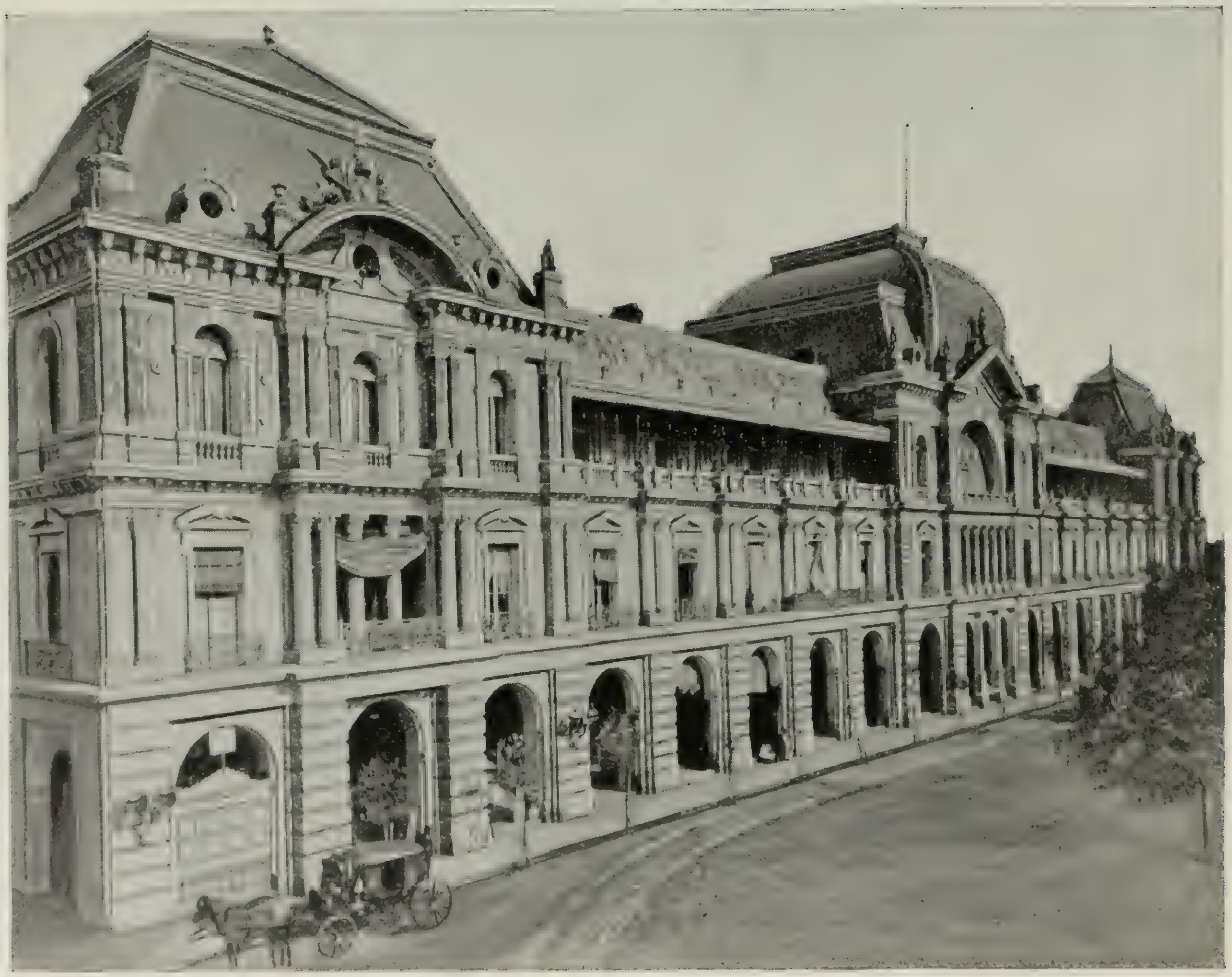
As might be supposed, the coke from these lignites is of inferior quality; moreover, it is compact instead of porous, and very brittle. Coke for metallurgical purposes is imported from the United States and Europe, and sells at 22 to 25 pesos (exchange at 24 pence) per ton. The coke produced in the Chilean gas-works is employed only for forge-work and domestic uses, and commands from 18 to 22 pesos a ton. The coal-tar from the gas-works is used in the cupellation furnaces in the silver-refinery near Santiago. One ton of the native lignite yields thirty-five gallons of tar.

Wood is still more extensively used than any other fuel. It is cut into short billets and sold by weight,—ranging in price from 13 to 14 pesos a ton, in the vicinity of Santiago, to 2 pesos and less in the south, where the forests are extensive. Charcoal, which is now used largely by private families, sells at 3 and 4 pesos for eighty pounds, but the government is proposing to establish large ovens in the wooded country in the vicinity of the gulf of Corcovado and Ancud, where it is said that charcoal can be produced at less than 10 pesos per ton.

Materials of construction for metallurgical works are not wanting, good clays for common bricks being abundant in all parts of the country, and many brick-yards being in operation. Such bricks sell now at from 15 to 20 pesos a thousand. Fire clays, however, are scarce. In the coal-districts, notably at Lota and Lebu, are good seams of semi-refractory clays, having the following average composition:

Silica, percentage	57.60
Alumina	28.00
Peroxid of iron	0.25
Lime	0.50
Magnesia	Traces.
Loss in calcination	13.50
	99.85

The bricks from Lota are the best, and have been found to stand well in the Siemens glass-furnaces which are in operation in that place. They sell at from 40 to 45 pesos a thousand, while imported fire-bricks sell in Valparaiso at 70 to 75 pesos a thousand. A large proportion of the copper bars exported from Chile is produced in rude reverberatory



GRAN HOTEL INGLES, SANTIAGO.

PRIVATE RESIDENCE ON THE ALAMEDA, SANTIAGO.

furnaces made entirely of common red brick, with a hearth of broken and pulverized quartz tightly rammed. Wood is used for fuel, and the whole operation is conducted by farmers and cattle-raisers who devote their time during the less busy seasons to this primitive metallurgy. The operations consist of a first heat, producing matte; subsequent heap-roasting; and a final smelting in the same reverberatory furnace, yielding the metallic copper, which is cast into bars of about 170 pounds in sand molds.

Chile is particularly rich in deposits of iron-ores, but no attempt has been made to utilize them for other purposes than fluxes. More than 4000 tons of iron-ore are produced annually from the San Cristóbal mine and shipped from the port of Coquimbo to Antofagasta to be used in the smelting of silver-ores. The San Cristóbal ores, however, contain considerable quantities of copper, but in the departments of Vallenar, Freirina, Serena, Ovalle, and Illapel, as well as in the central region (Tiltil, Lampa, Maipo), exist extensive deposits of hematite and magnetite, some of which assay as high as 66 per cent. of metallic iron. They are in most cases well below the limit in phosphorus and sulphur, and in many instances are associated with manganese. Large beds of the latter mineral are now being mined, the exportation in some years reaching 24,000 tons. One of the ambitions of the present administration is to create an iron industry on a large scale, and to this end it has sought suggestions from the National Society of Mines and

THE STRAITS OF MAGELLAN.

RESIDENCE OF SEÑORA COUSINO, SANTIAGO.

GROUNDS SURROUNDING RESIDENCE OF SEÑORA COUSINO.

OLD BRIDGE AT SANTIAGO, OVER THE MAPOCHO RIVER.

from the Society for the Promotion of Manufactures. The latter society has responded with a proposal to subsidize iron-works having some definite annual production. It is probable that such a plan will be followed, and may be extended to various manufactures, those of cotton, linen, superphosphate, glass, earthenware, paper, and matches having already been mentioned in this connection.

The Mining and Metallurgical Exhibition, opened in Santiago in September of this year, is another venture of the government, intended both to stimulate mineral production on the part of the Chileans by economical methods, and to elicit ideas for the fostering of such enterprises. The Pavilion of Chile at the Paris exposition of 1889 has been erected in the grounds of the Agricultural Institute at Santiago for the electrical department of this exhibition, and three other buildings have been provided for metallurgical appliances, motive-power plants, hoisting and ore-dressing machinery, and chemical processes. In addition to these a German firm has erected a complete sulphuric-acid plant, with a capacity of 2000 pounds daily. Applications for space have been made by twenty-five firms in the United States, ten in England, and thirty-four in Germany.

It is not improbable that this exhibition will encourage many new

RAILROAD BRIDGE BETWEEN SANTIAGO AND VALPARAISO.

A PRIMITIVE CHILEAN OX-CART.

ventures in Chile. There is no little native capital, which has already accomplished important results, and it is natural to expect that the initiative in large expansions of the mining industry must be taken by the Chileans themselves. The difficulties of transportation and labor have been a great obstacle to investments by foreigners, and these difficulties are best overcome by those born in the country. The coal-mines are owned and operated by Chileans, and nearly all the lesser industries are controlled wholly or in part by them. They are also large owners of the stock of the Huanchaca of Bolivia Silver Mines Company, which in 1892 produced more than 6,000,000 ounces of silver.

The saltpeter—or nitrate of soda—industry is altogether the largest which Chile possesses, but it is almost exclusively in the hands of foreigners. The production in 1893 amounted to 1,037,927 tons, and the total output from 1878 to 1893 inclusive was 9,244,056 tons. The history of these workings is so well known as to render an account of them here superfluous. They yield a revenue to Chile of some 15,000,000 pesos a year, and she is now realizing considerable sums from the sale of properties to which she acquired title by paying the certificates issued by Peru to the original proprietors when that government undertook what was tantamount to a confiscation of them in 1875. The government is at present highly dissatisfied with the state of the nitrate industry, which, it is charged, is conducted in an uneconomical manner, with antiquated machinery and clumsy methods. On the other hand, the nitrate companies fear that the installation of improved plants, tending to reduce the cost of the product, will only encourage Chile to increase the duties, since those from nitrate of soda constitute fully two-thirds of the total revenue of the state. This presumption may and may not be just, but it is only fair to point out that the Chileans argue that, since the production of sulphate of ammonia, which is the most dangerous competitor of nitrate of soda, has augmented to 23 per cent. of the total output of the mineral nitrates, it is necessary to offset this influence by lowering the cost of the latter article, thus encouraging a larger consumption, which would, without changing the rate of duties, effect that increase of revenue which she desires.

As a by-product from the manufacture of nitrate of soda, there result annually some 800,000 pounds of iodine, forming the larger part of that consumed in Europe. Large deposits of borax also exist in these northern provinces which Chile acquired from Peru and Bolivia, which are being worked to some extent.

THRESHING WHEAT IN CHILE.

The Chileans are fully aware of the need of improvement in means of transportation if any growth of industry is to be accomplished. The state now owns and operates 686 miles of railroad, and private lines bring up the total to 1847 miles. There are under construction an additional 448 miles, and a new railroad law has been passed rendering it as easy for future railroad companies to obtain charters, with full powers to acquire right of way, as for ordinary commercial companies to effect their organization. This plan is expected to stimulate the building of small lines to serve the interests of agricultural communities and smaller manufacturing and mining enterprises. Attention is also bestowed upon the common roads. The official records show 41,920 miles of public highways, and 24,800 miles of municipal roads, now open in the republic. These are mostly in an execrable condition, but in 1892 $550,000 were expended upon their improvement, and $450,000 were appropriated for this purpose in 1893. The seventy-eight navigable water-courses, aggregating 2852 miles in length, are being improved and added to. Fourteen bridges of various kinds were built by the state in 1892, and five more are being constructed or are under contract to be built.

From this very imperfect review it will appear that Chile has already made substantial progress, earning a fair right to the title of the "Yankees of South America" which her people often claim for themselves. But the growth of her urban population has been utterly disproportionate to the development of her resources, and the present striking activity in all quarters tending to a development of technical industries is a hopeful and healthful sign, showing that the people realize their weakness and their danger, and at the same time perceive clearly what remedy to apply. If they cannot find work as producers of raw materials, they must find work as artisans.

DEVELOPMENT OF THE STEAM-ENGINE GOVERNOR.

By Henry J. Conant.

> And thus I'll curb her mad and headstrong humour :
> He that knows better how to tame a shrew,
> Now let him speak ; 'tis charity to show.
>
> —*The Taming of the Shrew.*

THE Gentleman of Verona who married a shrew for her dowry, and proceeded to tame her, certainly undertook an easier task than was accepted by the inventor of the steam-engine, when the operation of his first crude hand-engine had demonstrated the feasibility of the use of steam as a motive power, and pointed out at the same time the necessity of providing some means to bring it under self-control.

It may fairly be said that the invention of the steam-engine, in any modern acceptance of the term, was not accomplished until some method had been conceived for making it self-regulating. To do this Watt applied his well-known governor. The device he used was the pendulum form of governor, which even to-day may occasionally be found, on some antiquated slide-valve engine in the backwoods, in substantially its primitive form. It was made to act directly on the throttle-valve and performed its office by controlling the steam pressure at the cylinder as changes in load might require.

If Watt's governing devices are considered in their entirety they possess little but historic interest, for the type of engine which grew out of his early designs is now so little used that it may be considered obsolete.

The subsequent introduction of the cut-off, and the use of steam expansively in the cylinder, offered new opportunities in the way of regulation and marked an era in the history of the steam-engine governor, as well as in the broader field of steam engineering.

Important changes were involved in the duties of the governor, and its action became in most cases indirect. The intermediate mechanism employed for operating the steam valves was so designed that the governor might, through its agency, vary the point of cut-off, and thereby maintain control over the speed of the engine by proportioning the mean effective pressure on the piston to the work to be done.

In a sense, therefore, it might seem necessary for clearness in discussion to treat the valve gear as a part of the governing apparatus. Such a course, however, would lead at once to a consideration of a multitude of devices for manipulating the steam valves, ranging from

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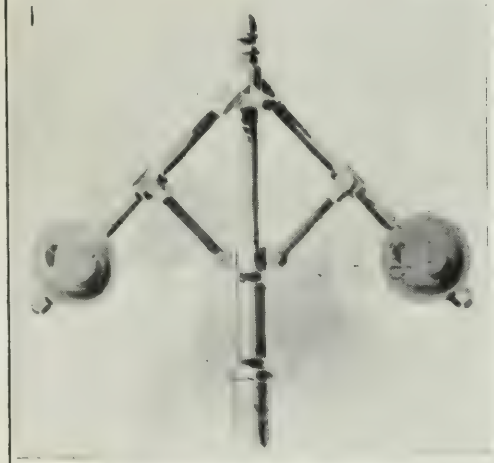

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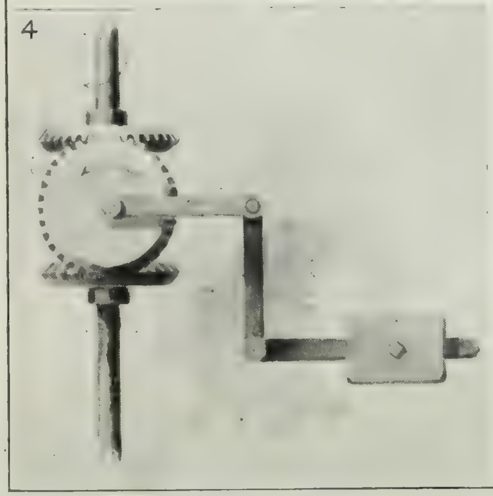

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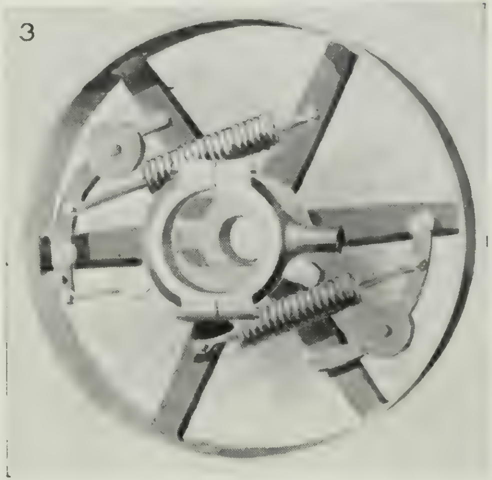

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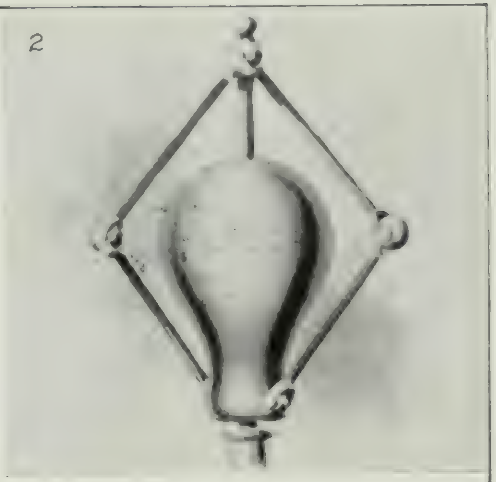

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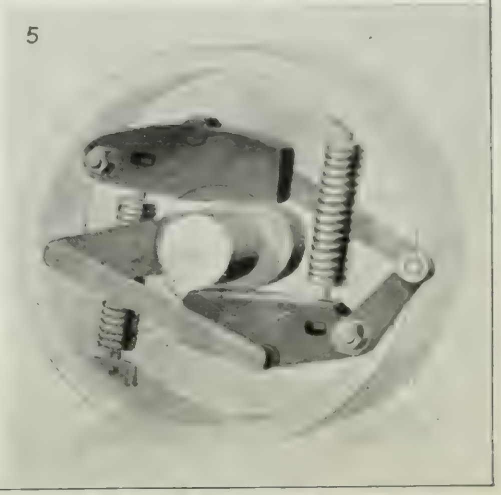

1. Pendulum Governor.
4. Siemens' Inertia Governor.

3. Sketch of Shaft Governor.

2. Loaded Pendulum Governor.
5. Modern Inertia Governor.

the comparatively simple mechanisms of the single valve automatic engines, to the various complex valve motions adopted by builders of engines of the Corliss type. All such would no doubt be found interesting, and many exceedingly ingenious, but as they are really only the tools with which the governor proper may do its work, and as any attempt to consider them would not only lead to almost endless digression, but add nothing to an understanding of the operation of the real governor, no further reference to them need be made.

With this view of the case it is easy to glance over the present types of governors and find that, with a few important exceptions, they remain in principle but little changed from the first crude device which Watt employed, and that they retain in a measure its defects.

THE pendulum governor as commonly used is a centrifugal governor pure and simple. Gravity is the restraining force opposed to the centrifugal action of the governor balls. Such a governor in its elements would consist of a pair of heavy balls suspended by arms from a central rotating spindle which derives its motion directly from the movement of the engine. In the simplest form of such a governor the different positions assumed by the governor balls by reason of their changing centrifugal forces at different speeds, would be made to operate directly on the valves to effect regulation.

The steam-engine governor was first used in this elementary form. But while it no doubt answered very well the requirements of those early days, a very little experience demonstrated its limitations and defects, and led to a study of the laws upon which the action of this class of governors depend.

AN analysis would show the position of the balls of an elementary centrifugal governor to be independent of their weight or their distance from the point of suspension, and determined only by their angular velocity. It was readily seen however, that any means by which the effect of gravity on the balls could be increased without augmenting their centrifugal effects, would produce a greater change in position for a given change in speed, and the governor be made more sensitive thereby.

The loaded pendulum-governor, as it has been called, was the natural outcome of such knowledge, and brought about at once a decided improvement in action. Loading of the governor has been accomplished in some instances by simply attaching to the balls a weight, the center of gravity of which lay in the axis of the governor spindle, in such a way, that it might act with gravity to cause them to fall, but without otherwise affecting them.

In other cases the action of gravity on the governor-balls has been reinforced by springs, and this method of loading the governor, while not perhaps a mechanical equivalent of the first, is yet capable of producing substantially the same results.

In the course of its development the pendulum governor has experienced many other modifications of design of a more or less interesting nature. Attention would be attracted to the parabolic pendulum governor, a refinement undoubtedly due, from its nature, to some one of a mathematical turn of mind. In this form of governor the balls are guided by a properly curved pair of surfaces, or suspended by flexible arms from evolute cheeks, in such a way that their path would take the form of a parabola. Since the subnormal of a parabola is always constant, the height of the governor would not change, and such a governor would therefore remain steady at one speed only, and be of course very sensitive.

Constructive and other difficulties have no doubt operated to prevent a general adoption of this form but it has sometimes been approximated by suspending the balls in the usual manner from points without the axis of rotation, corresponding to mean positions on the evolutes of the parabolas.

Other modifications of the centrifugal governor of a more radical nature have been made necessary by modifications in engine design, and a class of governors developed, which at first appears to constitute a distinctly new type. Reference is had to the shaft, or fly-wheel governors, now so widely used.

Such governors, however, with a few important exceptions* are really centrifugal governors in which the centrifugal forces acting are entirely counterbalanced by springs, thereby permitting their axes to be made horizontal. There exists nevertheless a distinct difference, for when this is done, new features are necessarily introduced by reason of the altered plane of action of the weights. The effects of these have rarely been treated in any useful way, and designers of fly-wheel governors as a rule have been content to develop their centrifugal effects alone.

Sufficient power is usually given to these governors to enable them to act directly on the valve motion, through one or more eccentrics whose relative positions they control.

It must already be evident that in order to perform its work at all, the weights of a centrifugal governor must alter their positions, and it will also be clear that when the governor acts directly on the valve motion, a measurable amount of force will be required to overcome frictional resistances. In some cases these are quite appreciable. Since the only force available to perform this work must be derived from a change in moments due to a change in velocity, it is apparent the governor would be restrained from operating at all within certain definable limits of speed variation.

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* Among the exceptions noted may be mentioned various forms of dynamometer governors, which have been used, and at least one shaft governor in which no springs are used ; gravity being retained as the restraining force, by the aid of a hollow shaft and various bell cranks and levers. But the most important exception is an inertia shaft-governor which has recently been perfected, in which centrifugal forces are subordinate in the act of governing, and inertia becomes the controlling feature of the governor. H. J. C.

It follows from this that there is in all governors of this class a deplorable feebleness of action, since for small changes in speed the corresponding changes in momenta are slight. Thorough lubrication becomes therefore an important consideration, and if long continued runs are to be made, means must be provided for effecting this continuously.

It is true that by relieving the governor of the greater part of its external work through the intervention of so-called tripping gears, or equivalent devices, the evil effects arising from these sources may be largely reduced. Yet the element of weakness still remains. The use of the tripping gear, moreover, is confined by reason of mechanical limitations to slow running engines, and this defect becomes therefore in general practice a matter of considerable importance.

But by far the most serious defect in all these governors lies in the fact that time is required to alter the positions of the weights. The governor cannot act until after the speed has changed.

How serious a defect this is, may be seen by considering for a moment the operation of such a tardy governor under frequent and wide variations in load, now so common.

It is evident that a lengthening of the cut-off due to a previous increase in load may occur at a time when by reason of its lateness, the load has fallen off, and a shortening of the cut-off is required to properly control the speed. This condition of things is by no means hypothetical, but in many conditions of service, is just what occurs.

A GREAT amount of effort has been expended in the endeavor to confine the results of these inherent defects within allowable limits. Designers have so far succeeded, in a variety of ways, that it has been possible, with any of the better class of engines to-day, to obtain excellent average results.

Modern requirements, however, have become so exacting that good regulation can no longer be comprehended in averages. Good regulation implies small variations of speed reckoned in revolutions per minute. But it means more. It means that there shall be no appreciable variation from stroke to stroke.

Whatever may have been the influences that controlled it, we recognize the fact that for decade after decade, the development of the steam-engine governor has proceeded on lines essentially weak. At most the type of governor in almost universal use to-day does not approach in theory, and scarcely approximates in practice, the requirements of perfect governing. It is clear that a perfect governor must act simultaneously with every incipient tendency to change in speed, and with sufficient vigor to eliminate the effect of all frictional resistances. Its duty is to establish—not an average, but a rate.

In view of all that has been said such a degree of perfection might seem beyond attainment. There has grown, however, out of an application of the familiar force of inertia a new line of development, which has led at once to a new order of results, the remarkable effects of which are only recently receiving proper appreciation. This does not appear to have been brought about, as has often been the case in other instances, until the possibilities of existing forms had been exhausted, and further improvement made radical departure necessary.

And although the more recent achievements in the inertia governor are so entirely original in their nature, as to give no suggestion of anticipation, it is nevertheless true, that a form of governor not generally known, embodying an application of the inertia principle in a crude way, was at one time tried, and subsequently discarded as impracticable. It has long lain forgotten, and only claims casual notice now, in the light of what is being done in lines at least remotely related.

This early attempt at improvement, although of little merit in itself, must now possess some little historical interest, and may be made to serve as a profitable introduction to a description of the modern inertia governor. Its conception was due to Siemens, by whom it was offered as a solution of the difficulties experienced with the rough form of pendulum governor in general use at the time. He retained the conical pendulum—but made it very heavy, and instead of driving it directly from the engine shaft as was usual, he introduced an epicyclic train of three equal gears, so arranged, that the intermediate gear was permitted a limited lateral movement, sufficient to open and close the throttle valve, to which it was connected by means of suitable bell-cranks and levers. The power required to maintain the pendulum in rotation came primarily of course from the engine. The lateral pull on the intermediate gear due to the constant resistance offered by the pendulum at its normal speed, was just balanced by a weight attached to one of the bell cranks.

So long as the speed of the engine remained constant, the speeds of the first and last gears in the train would be the same, and the intermediate gear with its throttle, would remain delicately poised in whatever position had been last assumed.

Suppose for a moment that with such a governor the speed of the engine were to change. Only two things could happen. Either all gears and pendulum would have to change their speed coincidently with that of the engine ;—or the intermediate gear would be carried to one side or the other to compensate the change in speed.

The pendulum, being massive, would refuse, by virtue of its inertia, to alter its velocity except by the expenditure of considerable energy. The intermediate gear. on the other hand, being counterpoised and free to move in either direction, would do so, and act immediately upon the throttle in a most positive manner. In fact the power employed to operate the valve would be derived from the engine itself, and act simultaneously with its change of speed.

So extremely sensitive can this device be made that a very small fraction of a revolution would suffice to move the regulator over its entire range. *

The device was crude therefore only in its application. In those days of universal slow speeds and rude engines, the perceptible retardation in passing the dead centers, and irregularities in speed due to other causes, would introduce sufficient disturbance to necessitate many complications in the form of dash pots, dippers, or other like expedients ; and it is quite probable that the one great virtue of this governor of Siemens was the cause of its final abandonment.

It seems strange that the inertia principle, so rich in possibilities, should have remained so long unused. Yet it appears to have lain forgotten until its comparatively recent employment in an entirely different manner, and in a way beautifully consistent with the natural development of the fly-wheel governor.

In general arrangement the inertia shaft governor is not unlike the ordinary fly-wheel governor. The governor weights are made unusually heavy—and their mass so distributed that their centers of gravity fall as far as possible from the path of their centers of suspension.

Their moments of inertia referred to the centers of suspension are therefore great in proportion to the moments of their centrifugal forces referred to the same points of support.

If such a governor be revolving uniformly on its axis, its parts will

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* A similar device for another purpose was successfully employed at one time in the Astronomical Observatory at Greenwich in connection with a clock train and other mechanism to provide an absolutely uniform movement of a drum, on which, by the aid of an electric current, it was possible to record the exact time of transit of the stars. H. J. C.

remain undisturbed in whatever position they may have assumed under the balance between the centrifugal forces of its weights and the restraining actions of its springs.

Imagine for a moment that the weights instead of being massive, were light, or that their centers of gravity lay on or near their circumference of suspension. Their effective inertia then being insignificant, they would readily accompany the engine in its changes of speed and no new position would be taken, until the speed had changed enough to develop a sufficient difference in centrifugal force to operate on the valve motion—as in the case of the pendulum governors.

Now suppose the weights to be heavy, and distributed as first described. They will, by their very considerable inertia, refuse to follow a change in engine speed, but simultaneously with any such tendency, and before centrifugal action could come into play, will assume new relative positions. The adjustment of the eccentric necessary to thwart these tendencies is therefore accomplished as in the case of Siemens' device, coincidently with any incipient change of speed, by a force coming from the engine itself, the power of which by suitable designs may be limited only by the strength of the governor parts.

The heavier the weights, the more obstinate their resistance and hence the quicker their action. Their relative motions may be still further augmented by placing the point of attachment to the eccentric, as far as possible from the point of suspension, thereby multiplying the speed of action.

As, in the case of Siemens' governor also, the operation of such a governor may be made so instantaneous and positive that the entire range of adjustment may be covered in a small fraction of a revolution, under the influence of a slight disturbance in speed.

It is evidently to the modern high speed engine, offering as it does many opportunities for regulation each second, that such refinements are applicable, if advantage is to be taken of them to the last degree.

If the inertia governor be carefully analyzed it will be seen to consist in reality of two distinct elements;—a primary centrifugal governor, and an inertia governor, both combined in such a manner that no additional parts are required, and so that both operate as one. Inertia is made to step in just where centrifugal action fails, and at once eliminates from the governor the serious defects that had previously existed.

It might properly be considered a compound governor, in which the function of the centrifugal component is to set a pace, and the office of the inertia part to maintain its rate. The details of design of such a governor are far from being as simple as the principles on which it depends.

Fortunately, however, all that has been accomplished in the slow development of the centrifugal governor and the insight that has been obtained into the complex forces that determine its action, are by no means lost, for a thorough knowledge of its laws and refinements is essential to any successful application of the inertia principle.

The modifying influences of a great complexity of disturbing elements involving the varying centrifugal forces of all parts of the governor, in their many different positions ;—the varying leverages ;—the constantly changing inertia of the eccentric and valve motion which it actuates ; and many other forces must be taken into account.

Some of these may be compensated, some made useful, proper allowance made for others ; and the effect of all combined in a way to produce the desired results. Ingenuity has been brought to bear where mathematics has shown defective design, and the art has finally been brought to a high state of perfection ; only, however, through the aid of this passive-acting, ever present force of inertia.

THE MANAGEMENT OF MEN IN MILLS AND FACTORIES.

By W. H. Wakeman.

THAT there is a way to succeed in the management of men in mills and factories, and many other ways that fail to secure the desired result, no reader of the history of labor troubles will attempt to deny, but just what plan to this end will prove the best one is still an open question. Neither can it be expected that any one plan will fit all cases, for that which proves effective in one instance may be useless in others. Strange as it may seem, there are still those who believe that physical strength is an important factor in this vexing problem, and that the foreman or manager who has the power and brute courage to promptly knock down an employé who is rebellious, or inclined to work to the disadvantage of his employer, is the proper one to be placed in authority. That such men sometimes do succeed in conducting a business profitably is no proof that their methods are good on general principles, or that they are the best that could be devised even in the special cases in which they succeed. There is one thing in their favor, however. When a delinquent is punished in this way, his punishment is not shared by those who are dependent upon him for their support, who are entirely innocent of any participation in his misdoings.

There is much to be said in condemnation of such a practice as is mentioned above, and many reasons for the belief that it is not good policy in any case. We can see nothing in it to warrant the idea that such a course will cause the laborer or the mechanic to have his employer's interest at heart, and, without this most desirable qualification, he will not perform his duties properly except as he is closely watched, and this state of affairs is to be avoided for obvious reasons. A certain foreman once said to a dilatory operative : "John, it takes half of my time to watch you." "Sure now, it takes all of my time to watch you," was John's unexpected reply. In the meantime what is to become of that keen appreciation of the value of time, without which it is difficult to make any business successful ?

The almost universal penalty for the infraction of factory rules and regulations is immediate discharge, but it is quite evident that the enforcement of this rule can never make any radical change in shiftless and vicious employés, for how can a man become a valuable hand after he is debarred from taking his accustomed place in the mill or factory ?

It is well understood that such punishment is not and cannot be of any benefit to the culprit, but is administered for the purpose of being an object-lesson to those who are still in the employ of the mill-owner, but it is also well-known that it does not always have the desired effect. We do not say that a man should never be discharged for a misdemeanor, but if his punishment is to have a good effect upon those who are retained, they must be convinced that it was merited and that no injustice has been done. It is quite often the case that, when an employé is discharged, his comrades are filled with resentment towards the foreman or superintendent who ordered his dismissal. Then the punishment does not have the desired effect on those who remain, but just the contrary. The fact that one man has the might to say that certain operatives shall no longer have a chance to earn their living in a certain place does not make it right for him to issue an order to that effect, for while some people formerly believed that "the king can do no wrong," the number who still hold to that doctrine is very small and continually growing less. The system of imposing fines upon those who spoil material, or produce imperfect work, has an element of justice in it, but, nevertheless, if a portion of a man's earnings is withheld, his family must suffer for it, although they were in no wise to blame for the fault. Can it be claimed that such a system is wholly just?

The practice of suspending an employé for a certain definite period comes under the same head. The prospect of being out of employment for a month has caused many a man to become discouraged, and the punishment has had the effect of making him worse instead of better, as the intention was, for there is always a large class of men to be found in every community who cannot or will not make good use of such time as may be at their disposal, but will spend it in drinking or carousing. When a man returns to his work after such a period of enforced idleness, it cannot be supposed that he will entertain particularly kind feelings for his employers, or be filled with a desire to work for their interests in every way possible. It is to be expected that he will be more ingenious in avoiding detection than he was in the past, but there is no reason to believe that his spirit has been changed, or that his nature has been improved by the fact that he has been deprived of work for a month.

If all of these methods fail, then, to what shall we turn for success? The guilty must not be allowed to go free, else all discipline will be at an end, and anarchy and confusion prevail. Having stated our belief that the foregoing punishments are seldom reformatory in their character or effects, it is in order to explain a method that may produce desirable results.

Every man who is worthy of the name has a desire to be considered honorable, honest, and square in all his dealings, and wishes to be treated by his superiors as if he were such. Now, when a man is careless and thereby causes a loss to the people who furnish him with employment, if he is called into the superintendent's office and his mistake is pointed out, and its effects portrayed to him in lively colors by means of kind but forcible language, and if, when this matter is made clear to him, he is told to go back to his work and be careful to see that the offense is not repeated, it puts him on his honor to do better in the future. If he proves by his conduct that he is striving to be worthy to retain his position, then it is evident that he is more valuable than ever before. If his mistake or blunder is repeated within a short time, then let his name be put on a bulletin-board provided for this purpose, so that all his colaborers may see it and know of his disgrace. This should be accompanied by a reproof more stern than before, but at the same time it should not be abusive in its character, and on no account should the superintendent allow himself to indulge in any form of profanity in an effort to make his remarks more forcible. If a man demonstrates that he is incorrigible, it will be necessary to discharge him, but even then it is a great mistake to use harsh language at such a time, or to send a man away without giving him notice of the intention to dismiss him. If he has proved to be unsuited for the work done in one factory, it is no evidence that he will not give satisfaction in another. If he finds the discipline in one place too severe, and the rules and regulations too exacting for him in the employment of one firm or corporation, it does not of necessity follow that he will not be able to meet every requirement in another place. It is not impossible to keep the good-will of men, even though they can not be retained in your employ, and no man ever attained such a height in business or social circles as to be able to afford to lose the good-will of his fellows. He may ignore some of them, but at the same time he cannot tell how soon these same men may be in positions where their influence will tell heavily either for or against him.

The plan here described of a system of punishment without loss of time or situation is not an untried one, but it has been tested on a rather large scale and proved to be a success. We do not claim that the same reproof or treatment in general will apply to all men alike, for we know to the contrary, but no punishment that deprives a man of self-respect, or the respect of his comrades, can be termed an unqualified success. Such a system as we advocate must be carried into effect by men who thoroughly understand human nature, and are wholly in sympathy with the proposed plan. If they do not possess these qualifications, then it will certainly prove a failure.

The writer once went to the superintendent of a factory to intercede for a friend who was not receiving fair treatment, but, even before the case was fully stated, he was confronted with the information that if he was dissatisfied, another man would be secured for the place at once. To adopt such a course as this is a great mistake on the part of manufacturers, for its effect is to arouse hostility and revengeful feelings, and no good can ever come of it. It would require but a short time to listen to a complaint of this kind, and, if it is a just one, to admit it and make some change for the better, or, if there is no ground for the complaint, to say so and give reasons for the decision. A conciliatory course in such matters has saved the annoyance and expense of many a strike and boycott, and both parties have maintained their dignity and self-respect at the same time. Employés are continually complaining that they are not respected by their employers as they should be. A careful analysis of a large number of such cases has convinced us that in a majority of them employés receive all of the respect that they deserve, but men are not apt to admit this, for, no matter how ungentlemanly may be their conduct, they appear to think that they are entitled to all of that deference which is almost universally shown to the dignified employé in whatever station he may be found. It has been a source of amusement to the writer at times to note that while the head of a firm will frequently recognize his employés on the street, some of the officers who are lower down in the scale appear to consider it beneath their dignity to admit that they know them. These may be considered small matters by some, but nevertheless they all have their effect in shaping the good or ill feeling existing between employer and employé.

It is very discouraging to men who are placed in charge of a department in a shop to experience difficulty in getting supplies necessary to carry on work to an advantage, and also in having repairs made at proper times. The foreman-blacksmith reports that he wants certain kinds of steel and iron at a stated time, but when the time arrives and he makes inquiries as to the delay, he discovers that the goods have never been ordered. The foreman-machinist orders tools that he needs for immediate use, but they do not arrive on time, and, when they do come at last, their number or quantity is less than he ordered. The box-maker orders lumber, but he cannot get it when wanted. The brush-maker orders wire and bristles, and has to wait a day or two before he sees them, and so on through the whole list. While we are well aware that there are sometimes good reasons for these delays or changes, in other cases there are not, but it seems as if, like the ancient Egyptian taskmasters, the shop-owner of to-day wants the bricks made but does not want to furnish the straw. We have known cases where coal was not furnished to the engineer until the last of that on hand was in the fire, and the engine was shut down waiting for more. If a man sends in orders for more material than is needed, they should be cut down, but nothing tends more to sour the disposition of the foreman of any department than to have his directions or requests in such matters totally disregarded. Again, nothing will make an engineer feel discouraged quicker than to report time after time that certain repairs or changes are necessary for the efficiency of his plant, and then to see the owner bring in some outsider who knows little or nothing about the place and its needs, who readily says that no alterations are necessary, and to find that this man has more influence with his employer than he (the engineer) can exert; yet scores of steam-plants are run in this way, and, in a great many of them, the engineer is right.

Such management of men is not confined to small plants, but is frequently to be found in places where many tons of coal are burned every twenty-four hours, and where a small percentage saved would amount to several thousands of dollars in the course of a year. The proprietors of these factories wonder why it is that, when they secure a good engineer, they cannot retain him, while their neighbors keep their engineers for years without a change. No self-respecting engineer will stay in a place where he is only expected to do manual labor or to superintend it, and the advice of a superintendent or bookkeeper is considered of more value than his own. Why do not manufacturers and steam-users understand this and act accordingly? The reply to this is sometimes to the effect that their engineers are not competent to tell what is needed, and superintend the alterations and the additions deemed necessary. To this we should simply say: "Then get one who is competent, without further delay." But there are cases where, if the engineer received the least encouragement, he would be much more interested in his work and be valuable in more than direct proportion. An instance occurs to us in which the advice of a superintendent was taken in preference to that of the engineer, and a large sum of money spent in making alterations on the engine, the result being that it costs about $5 per day more to run it now than it did before the changes were made. An engineer may be obliged to stay in such a place for awhile, but under such management it must not be expected that he will be contented, and under such conditions plants are seldom operated to the best possible advantage.

It sometimes becomes necessary to reduce the wages of employés to meet changed conditions of business. Now it is not to be expected that this will give satisfaction in any case, but we do maintain that it makes a great difference how the announcement of such reductions are made. To issue a peremptory order to that effect, implying or asserting that those affected by the new terms can accept them or pack up their tools and leave as soon as they choose, is one way. To take a little more time and explain that the market price of manufactured goods makes retrenchment necessary, is another. The average American workmen is capable of adapting himself to changed conditions, and will do it cheerfully, provided he is convinced that such changes are necessary, but where it is plain that a reduction in his income is made for the sole purpose of increasing the income of his employer he naturally objects to such management and will do everything in his power to make such an innovation unprofitable and unsatisfactory.

Again, men are sometimes compelled to work for low wages, and operate machines that are antiquated, in poor condition, and unprofitable in results, when the introduction of new machinery would enable them to earn more money for themselves and for their employers. This state of affairs exists where there is ample capital at hand to make all necessary improvements, but, owing to the fact that the proprietors are behind the times, the help employed must work at a disadvantage. Such management can never be satisfactory to the intelligent workman. We have known of men making experiments to demonstrate that other methods were superior to those employed who were successful in their efforts, but they received no recognition from those who should be most interested, sometimes being told plainly that their ideas were impracticable when they knew to the contrary. The result of such management, or rather mismanagement, is that these men seek employment elsewhere, and often find it with other concerns who are engaged in the same line of business, where their ideas are taken advantage of, thus reducing the cost of production, much to the detriment of their former employers.

Competition in nearly all kinds of business is so great as to make it necessary to profit by every good suggestion made by men who have worked for years at certain trades and gained knowledge in this way, and those firms or corporations who ignore this idea will discover, sooner or later, that the law of the survival of the fittest is still in force.

MODERN AMERICAN MACHINE TOOLS.

By Oberlin Smith.

OF the early history of machine tools we know but little, although the use of such simple devices as the bow drill, for instance, extends back through many centuries, perhaps even to the time of Tubal Cain himself. Ages ago a tool something akin to our hand-lathe was in use, the spindle being revolved alternately in two directions by a cord attached to one end of a treadle or "lath" from which I believe the word "lathe" was derived. We find that this supremely useful machine, nearly in the shape of our present hand-lathe, was the "whitesmith's" chief dependence in the early part of the last century—although automatically-fed lathes for irregular turning, and even for screw-cutting, were in practical use previous to the year 1680. In this same 17th century, and I don't know how much earlier, clock-wheels were cut in "engines" which were evidently prototypes of our modern gear-cutters and other milling-machines. Real machine-work, as we know it, began however only when the use of the hand-tool was abandoned and the slide-rest was substituted therefor. Maudsley did this in England about 1794, but an excellent device of the kind had been publicly described and illustrated in France as early as 1772. These forerunners of the to-come developed later into a more comprehensive sliding carriage running over nearly the whole length of the bed, thus forming essentially the present engine-lathe, so-called.

This machine, together with simple vertical drilling-machines and planers, essentially the same in principle as our present ones, formed chiefly the machine-shop plant of the early half of this century. The lathes and drillers had been so gradually improved during their long course of evolution that little opposition to their use seems to have been made by discontented workmen. This was not the case with planers, which, when introduced about the year 1825, were mobbed and destroyed, in order that the old process of filing and chipping plane surfaces, at a rate perhaps forty times as slow, might be preserved.

These machines, though supremely essential to the then budding era of American engineering which has since astonished the world in its fruition, were not nearly so convenient as now, and were vastly lighter and more "springy" in construction. This however, was partly compensated for by their architectural beauty, especially in the main castings, which attempted to rival all the orders of Greek architecture, together with a modicum of Gothic, Moorish, etc., thrown in. Our superiority over the ancients was however duly manifested by a gorgeous style of painting, which was calculated to make a really good rainbow blush with mortification.

Thus things went on, in this country at least, until something over thirty years ago when a new era began, chiefly instituted, as far as I can learn, by the Sellers and Bements of Philadelphia. A new type of machine was evolved, copied partly from the strong and heavy machines which had been developed by Whitworth and others in England, (but duly Americanized) wherein the aim seemed to be usefulness rather than ornament. Æsthetic considerations were not really neglected however, for in true art, as throughout nature everywhere, the use of proper materials, in proper forms, at proper places, produces the truest beauty, as well as the greatest utility. Foolish architectural frippery and multi-hued coloring were abandoned in favor of stiff "box-framing" of the simplest form, with the avoidance of external ribs, and with heavily rounded corners where practicable. Polished work was avoided to a great extent. Castings were made beautiful by their graceful curves and dead coloring of a shade natural to the material. More attention than ever was paid to strength and stiffness of the working parts, and to accuracy and durability of construction.

This English style of framing (or "Philadelphia style" as it was often termed in this country) was copied, with various modifications, until now nearly all our machine-tools are vastly different from what they were even twenty-five years ago, although the same general principles as were then in use are mostly embodied. One radical change made by the Sellers in planers, viz., the driving of the table by a worm-instead of a spur-gear, has added greatly to the usefulness and smooth-working of that machine. Another more recent but very important change of practice largely developed by the same firm, has been in a high-speed "return-motion"—the ratio of this to the cutting speed being on small and medium sized planers as high as 8 to 1, while on very large machines they have succeeded in getting 4 to 1, thus saving a great deal of time, with a consequent increased production.

A most interesting question in regard to the use of machine-tools is: "what degree of exactness can be obtained in practice?" This is somewhat according to what standard of comparison is used, for there is no doubt that when Watt in 1769 managed to bore his 18″ steam cylinder within 3/8″ of round and parallel, he considered that he had achieved a great success, although later, when trying to pack the piston traversing therein "with putty and old-hat" to keep the steam at the right end of it, he might have begun to dream of improvements in boring-mills. We have obtained of late years somewhat greater accuracy than this to the almost total destruction of the old-hat industry, and moreover, a steady improvement is all the time going on. So much is this the case that in some of the best lathes and planers now made, with special care in having uniform material and good workmanship, "scraped fits" have sometimes been obtained without any scraping; that is to say surfaces of moderate size have been made to so nearly touch each other all over as to be good enough for a working joint. Usually however the scraping off by hand of two apparently contiguous surfaces is necessary, the high spots on the work, after leaving the lathe or planer, being probably from .001″ to .005″ above the low spots, and having, undoubtedly, to a supposititious observer of microscopic size, the appearance of a fine rolling country.

As is well known, in the best modern practice the grinding-lathe and grinding-planer are used to supplement the ordinary machines using cutting tools, and by this means cylindrical, conical, plane and other surfaces are obtained of almost absolute accuracy, in regard to their roundness, straightness and flatness—that is where the work itself is stiff enough to retain the shape given it without perceptible distortion by gravity, etc. The reason of this additional accuracy is found in the fact that the emery-wheel which does the cutting moves at such a high speed, and has such innumerable little cutting edges, formed by the individual grains of emery, as to require no appreciable pressure to hold it against the surface of the work, on account of each little tooth taking such a very little bite. Thus the wheel does not spring away from the work and, on the other hand, the work and its supports do not spring away from the wheel—either bodily, or at individual spots by the bending of the work. This grinding process is now used for many ordinary purposes, and has even been adopted by at least one manufacturer, as a substitute for turning, upon such things as cast-iron gear-wheels, which, by the way, do not require any particular accuracy. A few years since this grinding process was only in its infancy, but was then considered necessary for the trunions of astronomical telescopes, as the accurate motions required therein had developed the fact that ordinary lathe-work was neither round nor straight.

It may be asked by the geometrician, who sees in an engine-lathe merely the embodiment of the beautiful principle of revolving a plane figure about an axis to produce a solid, why such lathe will not make a true cylinder, considering the fact that it is a mere copying device which should leave the piece of metal treated in it in any shape ordered by the brain of the maker and operator. To answer this question he must consider in the first place that all metal acts, when subjected to stress, exactly like a piece of india-rubber, only in a less degree. Granting that the lathe in question is itself accurately enough made and strong enough (neither of which is usually the case) we find several reasons why the path of the tool-point does not lie in the surface of a true cylinder. One is the lack of homogeneity in the work, it usually being of different hardness at different places, crowding away the tool more or less in various spots as it passes around. Another reason is the original shape of the rough work, the tool being crowded away more where the heavy parts of the cut occur, and this action being repeated in a less degree in successive cuts, even down to the finishing one, the completed work thus being in some measure a copy of the rough material. Another reason lies in the bending of the work itself between its points of support, as will be easily seen in attempting to turn a rather slim shaft without other support than the lathe-centers at the ends, the middle crowding away from the tool and being very perceptibly bulged. Still another reason lies in the tool gradually getting duller from start to finish, having more and more tendency to be crowded away from the work as its cutting edge becomes rounded off. Still another lies in the fact that various vibrations are set up in the work and the machine, which are of course somewhat rhythmical, after the manner of a musical reed, but which, owing to irregular shapes, must form a good many interferences and give a confused result. These obviously tend, by the inertia of the parts, to make the tool cut more or less deeply in different spots. The geometrician would probably further ask why the tool could spring away if the machine was strong enough but this would only show that he had not yet mastered the india-rubber analogy before referred to.

In planing, milling and other operations the same conditions as have been described for the lathe are of course existent in regard to the planes and other surfaces which are being attempted. A particular exception to this action exists in such tools as drills and double-ended boring-cutters, which obviously cannot yield appreciably in respect to diameter. In regard to crookedness, however, these tools can fully hold their own as examples of the total depravity of inanimate things, the lack of straightness in long holes of small diameter being one of the most trying problems to be solved by the practical machinist.

In general, the improvements which have enabled so much more and better work to be done in our machine-shops than was done a quarter of a century ago, have consisted, to a great extent, in making the machines heavier and stronger and also much more convenient to manipulate. A greater gain, however, has been made by the use of special machines for special operations, as for instance axle-lathes, pulley-lathes, car-wheel-borers, etc. Such a machine is especially adapted to do some particular kind of work far better than any other machine could do it, and is not adapted for a lot of miscellaneous work so that there is a temptation to change it over for something else and not have it ready when wanted for its own special functions. A system like this has enabled a 33″ car-wheel having a hole about 5″ in diameter by 7″ long to be mounted, chucked, bored (two cuts) and dismounted in six minutes. Such work can be done at an average speed all day long of a wheel every 8 minutes, or 75 per day. It goes without saying that this work would take vastly longer if done in an ordinary lathe—probably from 10 to 20 fold, as work is carried on in jobbing shops.

Machines of this sort are constantly increasing, and some of them are very elaborate affairs, arranged to bore a number of holes at once of different sizes and in different directions, combined also sometimes with special facing and tapping apparatus. Such machines have been very successfully used for the frames of mowing-machines, for steam-pump and locomotive cylinders, etc.

Of late years another class of large machines not so highly specialized has come into use for drilling, tapping, boring, facing and milling a variety of objects suited to receive their services, such as the main frames of engines, presses and so forth, these machines being adjustable to a variety of positions and not limited to one particular size and style of work. Another special-general machine, so to speak, which has been chiefly developed in this generation is the turret-lathe. Than this there is perhaps no more beautiful example of the enormous gain in speed and accuracy obtainable by performing successive operations with specialized cutting-tools so arranged as to successively and quickly locate themselves exactly where they are wanted, and to definitely limit their own performance, without interference from the varying judgment and "personal equation" of the operator.

Another element in the cheapening of machine-work, more especially abroad than here, has been the introduction of hoisting and forcing machines for lifting, locating, putting-together and otherwise handling heavy pieces of metal. These valuable adjuncts to machinery plant consist chiefly of quick-acting cranes of various kinds, and also of hydraulic and other presses for assembling work. The recent introduction of the electric crane, which is so easily adaptable to almost every possible condition of force, speed and direction, marks almost a new era in handling machinery.

The use of accurate gages, micrometers and various other measuring and laying-out apparatus has also much facilitated modern work, as has also the use of various improved small tools, such as twist-drills, taps, reamers, etc., made by specialists on the "duplicate system." All these things have helped forward the standardization of various units which enter into the make-up of a complete machine. These units are themselves frequently made by regular manufacturers who do nothing else, and who therefore attain much greater cheapness and uniformity than could possibly occur with the individual machine-maker, who could make but a few at a time, and with poorer tools. It is therefore the policy of the latter to purchase ready-made whatever articles he can find in the market, such as finished nuts, washers, bolts, keys, set-screws, dowel-pins, handles, shafts, pulleys, fly-wheels, gears, etc.; and there is an increasing tendency all the time to make up standard machinery in this way, as well as to unify the standards themselves.

In addition to the improved tools mentioned for building machinery in the ordinary way, there are methods of cheapening manufacture to an almost infinitely greater degree, where a great number of small articles are to be made in duplicate on the interchangeable system, as is the case with sewing-machines, pistols, watches, etc. These can of course be produced as cheaply as they are only by the very highest form of specialization, not only in the machines which turn and bore and mill the parts, but in the extensive use of locating and sizing tools, mostly consisting of jigs, templets, and gages. A comprehensive description of these potent factors in our modern civilization, second only to the printing-press itself, and using the same general principle of enormously multiplying the results of the original brain-work by means of sinews and muscles of bronze and steel, managed without fatigue by the cheapest form of labor, would require a volume, if not an encyclopedia, in itself. A single example of the cheapening processes in question may be seen in the case of a sewing-machine which can now be produced at a cost somewhere between $5 and $10, with better workmanship and more accuracy than could be obtained in an ordinary machine-shop, by an expert workman with his usual tools, for perhaps a couple of hundred dollars. The difference between these two methods is evidently the same as that between the work of the monkish bible-maker of the middle ages, toiling for years over a single volume, and the "lightning printing-presses" of the American Bible Society.

The future development of our machine-shops is difficult to foresee, but will, I think, be somewhat as follows. Our lathes will have very much larger spindles, both live and dead, the former, especially, being increased in diameter perhaps even three- or four-fold, where used for chuck-work, as we cannot afford much longer to go on practicing an outrageous sacrifice of time of machine and operator for the sake of saving a little journal friction. These lathes will have more convenient devices for reversing and changing feeds and will, like our most modern planers, be easily set to take a feed from 1/2″ to 1″ wide for certain finishing operations, etc. They will, too, be more specialized into chucking, center-turning, screw-cutting and polishing lathes, and will not attempt to perform any of these functions at will as much as is now the case, thereby nearly spoiling the machine for all of them. A chucking lathe with the spindle as large in diameter as is its average work is no worse in respect to friction than is a planer with its table-friction moving at the same speed as the cutting. We shall therefore have 20″ swing lathes with the large spindle-bearing 10″ or 12″ in diameter, instead of the pipe-stem affairs now in vogue. The framework of these lathes will of course be greatly increased in weight and stiffness—as will also the driving-gear.

Our drill-presses will follow pretty much the same lines and will be arranged with a reversing gear to facilitate tapping, left-handed facing, etc. They will be supplied with portable turret-tools, so that several sub-operations can follow each other without re-setting the work.

Our milling machines too will follow suit, having more convenient changes of feed, vastly stronger spindles, driving gear, etc. In all of these tools there will be a tendency to drive by worm- rather than spur-gearing, thereby easily applying greater power, avoiding undue vibration, and getting the smoothness of motion attained in the planing machines before referred to.

Our planers, shapers, slotters, etc., will be improved chiefly in the line of vastly greater stiffness. Especially will this be the case in the main side posts of the ordinary type of planer, which always have been, and still are, ridiculously weak in a lateral direction, making it (as is well known to every machinist) almost impossible to produce a vertical planed surface with anything like the degree of flatness that is attained in horizontal work laid directly upon the table. Why these posts should always have been made so strong fore-and-aft to take the direct stress of the tool, and have been made so extremely "floppy" in the other direction, has entirely passed my comprehension.

Our gear-cutters will, it is to be hoped, be vastly improved by making the indexing spindle four or five times as large in diameter as at present, with proper arrangements for driving the gear-blank to be cut with some clamping or chucking device so that it cannot slip around upon its arbor, as is now often the case, especially if the cutter is sharper upon one side than the other. That the spindle itself shall not yield torsionally between the working end and the index-wheel is of course sufficient reason for greatly enlarging it—and there is no possible objection. These spindles should also be hollow, with a large opening that pinions may be cut when made in one piece with their shafts.

The above are but a few instances of the radical improvements wanted. In general, it may be said that the most important change required is an average doubling or trebling of the weight, for a given capacity, of all sorts and conditions of machine tools. This use of what the writer has for some years past, in various publications, termed the "anvil-principle," in contradistinction to the "fiddle principle" now embodied in so many of our machines, and particularly in those familiarly known as "Yankee tools," will undoubtedly do more to increase the production, as well as the accuracy of our machine-shops than any other one thing. This increase can be very cheaply purchased with cast-iron at its present, and probably future price, and with it will be purchased a freedom from vibration and a capacity for *heavy cuts* not now, I think, realized by most shop-owners. In regard to materials for machine-tools the old stand-by, cast-iron, seems good enough for most purposes and very difficult to improve upon. Yes, even for lathe-spindles, although possibly it may not yet be quite orthodox to say so, there is probably nothing better than this metal, running in boxes of the same—*provided* the diameter is large enough.

Another radical change which the near future will probably see in our machine-shops, will be the abolition of shafting and belting, and the direct driving of each machine with its own electric-motor, simple pieces of conducting wire coming up through the floor, being substitutes for the tangled mass of timbers, hangers, shafting, pulleys, clutches, counter-shafts, shipper-rods and handles, ropes, belts and weeping oil-cups which are now the source of so much noise, inconvenience, danger and waste of power. Each machine handling heavy work will probably be provided also with its little electric-hoist acting as an auxiliary to the electric traveling cranes which can then traverse unimpeded the whole field of every ceiling.

Besides the improvements in *matériel* which we have prefigured, the *personnel* of our machine-shops will undoubtedly be greatly improved, not only by an influx of many more workmen from our technical- and trade-schools than we have hitherto-enjoyed, but by the moral and mental influence upon all the men of the cleaner and lighter electrically-driven, -lighted and -heated shops, which the future will bring us. These men will, by their more scientific methods, and by a more rigid system of shop government, learn to waste less time than now in laying-out and in setting their work, and will cause their machines to waste less time by the ridiculously light cuts and narrow feeds which are yet so prevalent, even in some of the best shops.

What the future may do in superseding entirely some of our present crude processes by some system of separating metals in proper lines of cleavage, instead of forging and casting the wrong size and shape for the sake of paring and scraping a good deal of it away in chips, it would be only chimerical to prophesy. It seems very certain that in this generation we must go on plowing and digging down to the finished surface of our work, as in the past; but potent factors which will enable this to be done more sensibly and at a considerably higher speed than we are accustomed to, will be by more metal plus stored-up brains in machines, and by more brains plus training in men who operate them.

A REVIEW OF AMERICAN MINING LAW.

By W. C. Wynkoop.

THE student of mining must recognize the important influence, either retarding or stimulating, which the laws and customs of different countries have exercised and are exercising upon the great industry. Mechanics and chemistry have had scarcely more influence upon its development and progress. But with respect to this branch of law, as it is with all others, there is wide difference of opinion, both as to what is or would be best. Perfection is far away.

It would be interesting to trace the development of mining laws in all countries, from ancient times, and show that their growth has been analogous to that of the common law, which is the development of the necessities of mankind into custom and practice. It is true that mining law can be found in the statutes instead of court decisions, or is supposed to be statutory; but the supposition is not entirely correct. Many of us have seen and can still find districts in the United States where the rigid application of the statute has appeared to be so inequitable that despite the instructions of judges, juries have refused to do their share toward enforcing it. And this recognition of equity in opposition to statute law has become so well known that custom has made a '' higher law '' or practically repealed the objectionable features of the statute in these places. But it is not necessary to go to ancient history to find material which is interesting to the American miner.

The first act in relation to mines in the United States was passed in 1785. As passed by congress, it was an amendment to an act which proposed to charge a royalty on bullion product. This part was stricken out, and one-third part of all discoveries of gold, silver, lead and copper mines was reserved to the government. Its impracticable nature was determined after the active development of the lead mines in Missouri began. In 1827 they were excepted from the act and in 1829 an act was passed providing for their sale to individuals, and the relinquishment of all government title to them. An act of 1846 provided for individuals getting title to lead mines in Illinois, Arkansas, Iowa and Missouri. Other acts were passed, as necessity arose, providing for the sale of mines in Wisconsin and Michigan. After the acquisition of California, the only law affecting title to gold and silver mines, anywhere west of the Mississippi river, until 1866, reserved them from sale. The result was that from 1850 to 1866, a period of 16 years, there was no law by which any one in the far west could get a title to a mining claim. Every man who worked one was a trespasser upon government property. It was then that mining districts were formed, each one enacting its own laws and regulations, which were always incomplete and imperfect, but were supplemented by customs, which though different in different districts, were generally fairly well suited to the requirements of each case. In those days, when disputes arose, miners organized their own courts, where all differences were quickly settled without attorneys, court officers or expenses. The now indispensable and costly mining expert witness was not yet born. Our present mining laws may be said to have been evolved from those district laws, and are, perhaps, as near as skill can make them, a codification of the principal customs of those days. That they are not exactly equitable in all cases, is because geological conditions, which are closely connected with equities in mining, are so variable and unlike in different regions that probably human skill could not codify laws which would be justly applicable to all alike.

In the early days in the mining regions, the district laws almost everywhere made lode mining claims from 100 to 200 feet in length along a lode, in most cases only 100 feet, and restricted every man to one claim on a lode, unless he were the discoverer, in which case he was generally given two claims. Gulch or placer mining claims were even smaller. If they were in a narrow mountain valley, they were generally 50 or 100 feet along the stream, reaching from one side of the valley to the other. These district laws everywhere were based upon the theory that every man should have a fair chance at the mining wealth, and that no man should monopolize more than his share. At first there was seldom any law requiring a locator to perform any labor, or do any development on a claim, the presumption being that no man would take a claim except to work it. But this was soon proven incorrect. There were men who devoted their whole time to acquiring claims, for the purpose of selling them, and this struck the sense of justice as being wrong, so the universal rule soon became one to compel the performance of a certain amount of labor on each claim in order to hold it. The amount of labor required to hold a claim varied from one day per week, to practically constant work. Wherever there had been the most aggravated cases of "hogging" or monopolizing claims, there was sure to be a rule requiring the largest amount of labor. I remember hearing one rough miner-orator addressing a meeting around a camp-fire one night, who said "air, water, the earth and all its mines belong to humanity, and no man has any human or divine right to monopolize any more of any one of them than he can use." And this was a doctrine of use, which everywhere became popular, and which was enacted into our present statute regarding unpatented mining claims. The evil of one man locating a host of claims in a district and holding them for speculation soon manifested itself, and was easily and effectively corrected by district laws, compelling stated amounts of labor to hold titles.

But there was a great annoyance and considerable friction arising from the marked difference in the laws of adjoining districts, and the frequent impossibility of telling in which district a claim might be located, and consequently under what laws it was held. The annoyance from these causes became so great that the enactment of a statute by congress in 1866, giving men a right to locate and obtain title to mines on the public domain, was welcomed. It promised uniformity where there had been confusion, and immediately upon its passage the district organizations were generally allowed to pass out of existence. Subsequently locations were almost universally made under the United States statutory requirements.

The old lode locations of 100 feet each were made under district laws framed by men who were almost all ignorant of the art of mining. The object in limiting a man to such a small part of a lode was to prevent the monopoly of too much ground by one man. There was a fear that nature had been very niggardly in her creation of veins, and that unless the size of locations was restricted to small dimensions there would not be enough to go around. It needed but a little experience to demonstrate that 100 feet on a lode was not enough ground to pay for any plan of mining development. On this account the act of congress of 1866 made the length of a lode location 1500 feet. But this act did not require locators to do any work annually, or otherwise, to hold their claims. When a man had made a location in compliance with the law, he was under no obligation to do anything more to hold it and retain its legal possession. The result was that the entire known lode bearing portion of the country was soon covered with locations made by men who were unable or unwilling to develop them. There were numbers of poor prospectors who each had from fifty to two hundred mining locations. The law made them impregnable in their dog in the manger position. The country was being stagnated and the mining industry was being rapidly stifled and killed by this act. The result was seen in the production of precious metals all over the west, outside of the Comstock mines. It was rapidly declining. In Colorado the production for the 14 years preceding the law of 1872 had averaged about $2,000,000 per year. Immediately upon the passage of that act it rose to $4,000,000 the first year, and has been increasing steadily from year to year till it now equals about $30,000,000 annually. One principal cause of the increase was this change in the law.

There were two very important features in the act of 1872, one of which has been beneficial, and the other, according to a wide-spread belief, has been injurious to the industry as a whole. The act changed the rule under which locators could hold claims. It required that on an unpatented claim the locators must annually perform labor to the value of at least $100, and a failure to perform such labor forfeited all his rights, so that the claim became open to location by others. The result was that nearly all the thousands of claims held by men who could not or would not comply with the law, were relocated. Among the best mines in the west are many which were so relocated, and which, but for such a law, would yet probably remain unproductive prospect holes. To this feature of the law of 1872 can be credited much of the impulse given to mining, which in its turn has caused the construction of thousands of miles of railway, built populous cities and towns and added over a billion dollars to the permanent metallic wealth of the country. The main weakness of the "assessment-work" system is the uncertainty in determining whether the law has been rigidly complied with; but that is a question for the courts, as each case comes up.

The second feature of the law, about which there is a wide divergence of opinion, but which the majority, perhaps, believe has had an injurious or retarding effect upon mining, is the one which gives lateral rights to a locator. That is, where a locator has the apex of a lode entirely within the side surface boundaries of his claim, he can follow it downwards on its dip wherever it may go. During the past fifteen years lawsuits, involving the ownership of properties worth millions of dollars, have been constantly before the courts, often leading to bloody combats between rival claimants, but more often frightening capital from investment in mines or their development.

The law of 1872 is commonly supposed to have been framed to apply to typical fissure lodes in granite rocks, where the walls are well defined and the lode easily followed. As applied to such there was and is equity and fairness in allowing a locator to follow his lode on its dip to any depth. But the mining engineer knows that there are two distinct types of ore-bearing mines, though they may be divided into as many classes as the fancy of each man may dictate. These two types may for convenience be called regular veins and segregations. The first have well defined walls; their best types are found in granite or eruptive rocks. The segregations are generally found in limestone or other sedimentary rocks. They are irregular in shape, and are without well defined walls. The common opinion among working miners is that these segregations are not veins or lodes, within the meaning of the law, and that the law was never intended to apply to them, and cannot equitably be applied to them. The U. S. supreme court, however, has given a legal definition of a lode or vein which makes the law applicable to segregations; but notwithstanding this, and the instructions of judges, juries often refuse to find verdicts for the apex claimants in cases where the ore deposits in conflict do not correspond with the ordinary miner's idea of what constitutes a vein or lode. It seems to be impossible for the average miner, especially if he has had his experience in mining in a granite or eruptive rock country, to conceive of a vein which has not two good walls. The great majority of such miners have formed their idea of a lode from the old geological idea that all were once open fissures in the crust of the earth, which were filled with ore after they were formed, and that nothing which does not correspond with this idea is a vein or lode within the meaning of the law. And they believe that this idea is purely scientific, and that any definition which does not recognize this mode of lode formation must be and is nonsense. The common idea was once well illustrated by what several jurymen in a celebrated mining case said to me. They refused to find a verdict in accordance with the instructions of the judge, and gave as their reason that "the judge knows more about law than we do, but he don't know as much about mines."

Probably very few mining engineers will to-day question the scientific accuracy of the definition of a lode or vein which the judges of the supreme court have given. It would be a bold man who would say that it is possible to draw a distinction between the different kinds of mines, with reference to their genesis, which the law could recognize.

There is an interesting fact connected with the drafting and passage of the mining law of 1872, our present law, now generally forgotten. The act as presented in congress was drawn by a commission consisting of Profs. Whitney, Clarence King, and Mr. Williamson, commissioner of the General Land office. Messrs. Whitney and King were geologists of established reputation. The act as drawn by them gave no lateral rights to locators. Miners were to be confined in their underground workings to the region embraced in the vertical lines of the boundaries of their locations. It was amended to give locators the right to follow their lodes or veins on their dip beyond their vertical side lines, when the apex of their lode or vein was wholly within their surface boundaries, the lode or vein running longitudinally with the surface location, and passing out of the end lines. Messrs. Whitney and King both predicted that the result would be to promote litigation, and their prediction, founded upon a geological knowledge of ore formations which legislators did not possess, has proven correct.

The feature of our present mining law which grants an absolute title to mines to individuals, absolved from all conditions, I am convinced is one which is wrong in principle, and injurious in practice.

One can now get a complete title to mining locations by patent, after which he can hold them forever, without compliance with any further conditions. The result is that all over the mining regions there are hundreds or thousands of patented mining properties lying idle and unproductive. There is only this check upon patenting, that it involves some expense, trouble and delay. It is a return, in some degree, to the conditions which prevailed between 1866 and 1872, when mine owners owned property which they could not or would not work, and which others could not work. There are many portions of the mining country whose prosperity and development are seriously retarded by the great number of idle patented properties covering them. Of course it would be impossible for the United States to enact any law now which would affect the title of these properties, and impose any conditions upon their owners except upon the basis of compensation to present owners. But it is not impossible to legislate for the future so that the laws would have a tendency to promote mining development instead of retard it. To do this the country has only to adopt a system analogous to that of other countries which are rich in the precious metals. In most others the governments never part with their their fee to mines; they allow men to work them under prescribed conditions. Often the only ones are that a certain amount of labor shall be performed each year, as our government now prescribes for unpatented mining properties. The purpose and effect of such laws is to induce the development of mines and the production of value, and at the same time promote the general welfare, as it is always promoted, by giving remunerative work to workers.

It is a question, too, whether our present mining law is not, in so far as it permits of the acquirement of title to mines without continuing conditions, a violation of fundamental principles of right. In the case of the utilization of water for irrigating purposes, the one who first appropriates it has the prior right, without cost, to its use, with which no one can interfere so long as he continues to use it. But when he ceases to use it himself others have the right to use it, which right continues so long as they continue to use it. The government here recognizes, so far as water is concerned, the principle mentioned by the miner-orator referred to, who declared that "air, water, the earth and all its mines belong to humanity, and no man has any human or divine right to monopolize any more of any one of them than he can use." In other words man can acquire an equitable right to that which he creates; but things which are a part of nature belong to humanity, and no man has any right to exercise control over them except as he makes use of them.

LIGHTNING AND LIGHTNING-CONDUCTORS.

By Oliver J. Lodge, F. R. S.

EVER since the time of Franklin, civilized man has has been accustomed to take some precaution against the destructive agency of lightning on his dwellings. A simple conducting-rod from top to bottom, stout enough to be safe against melting by any current it may have to convey, pointed above and rooted below, has been the protective agency more or less effectively employed. Not until quite recently, however, have the real conditions of the problem of protection been fully grasped. Franklin and his followers did not know of the possibility of electric oscillations. They did not think of a charged cloud as a great store of energy which somehow or other has to be dissipated ; they thought, and the world until lately has thought, of a charged cloud as a reservoir of electricity which desires to come down to earth, and they supposed that the sooner and the quicker it was let down the better. The only thing they aimed at, therefore, was to make for it an easy path ; and they thought that, by making one path easy enough, all other paths would be protected within a certain radius. They thought, in fact, that the path of least resistance would be chosen and that others would be spared. Consequently, wherever a lightning-rod failed entirely to protect ; wherever a side flash sprang from it to other, and apparently very inferior, conductors ; wherever gas was ignited by apparently quite detached and unstruck conductors,—it was customary to abuse the lightning-rod as having been badly erected or imperfectly tested. And since the portion underground was less conspicuous than the rest, and did indeed lend itself to poor workmanship more readily than the upper portion, it came in usually for the larger share of blame. Sometimes the blame was deserved, sometimes probably it was not ; but we see now that in no case can a defective earth be held accountable for the whole of the mischief. The mischief lay in the laws of nature, or rather in the inadequate acquaintance with those laws possessed by the philosophers of the time.

When a spring, like a thin bar of steel clamped in a vise, is bent aside and released, it recoils to its old position, but in so doing it is apt to overshoot its mark and to swing several times to and fro, with rapidly-decreasing amplitude of vibration, before finally settling down. A load attached to the free end of the spring makes it oscillate more slowly, lengthens the period during which the oscillations last, and renders the existence of oscillation more certain. For, though they are common, they are not essential accompaniments to the release of a spring. By friction, or by other forms of obstruction, one might arrange that the recoiling body should slide back quietly and slowly into its old position, without any overshooting and oscillating recovery. In other words, friction may cause the motion to be dead-beat, or, if excessive, may go beyond this and allow only a slow and gradual recovery like that permitted by a small leak in a vessel of compressed air. A massive or well-laden spring will, other things being equal, be able to maintain its oscillations in the face of a larger amount of friction than would be possible to a light unladen spring deficient in inertia. The recovery of this last would readily degenerate into a mere leak. Whether the recovery be slow or sudden, whether it be much resisted or almost free, in all cases the following statement holds good. The bent spring is a store of energy, which energy must all be dissipated before the recovery is complete. The energy is not destroyed, of course, but only dissipated,—that is, changed in form and transferred to other bodies ; this indeed is what must become of any store of energy if it is to be released and made active. Whither goes the energy of our spring, and what becomes of it? Into sound partly if the vibration be rapid enough ; into heat wholly if vibrations are checked altogether by abundant friction. In one peculiar case—if it be allowed to vibrate at or beneath the surface of a liquid—some of its energy may take the form of surface waves traveling out from a center, and traveling perhaps a long way before their energy is, in its turn, otherwise dissipated.

All these things are an allegory. An electrified body is a store of energy similar to the bent spring. The only difficulty about it is that, whereas in the spring it seems comparatively easy to lay our finger on the strained material and to point out the precise reservoir of the energy, in the electrical case it seems a little more mysterious and difficult. Something round about a charged body is certainly in a state of strain, and, when permitted, it will recoil as the spring did, and everything we have said concerning the spring has its analogue in electrical behavior ; but that something is not the body, nor is it the air, nor is it anything in the ordinary sense material ; it is, as a matter of fact, the ether. But, whatever it is, the discharge of the body corresponds to the release of the spring. The electrical resistance of the discharge-path corresponds to friction ; the inertia of the spring, whereby it overshoots its mark and oscillates until sufficient time has been allowed for its energy to disperse, is called, in electrical language, "self-induction." But whereas, in the case of the spring, it was optional whether or not it should be immersed in a wave-propagating medium whereby some of its dissipated energy is accounted for, in the electrical case there is no such option ; for every electrical event, as every other event, occurs in the all-pervading medium—the luminiferous ether. When a discharge is slow, that is, much resisted, no oscillations take place, and the result is only heat. When the resistance offered to a discharge is moderate in proportion to the energy requiring dissipation, the whole of it is not got rid of in one swing, nor yet in two, but the swishing to and fro of the electric current, every swirl of which excites far-spreading ethereal waves, may continue for ten or a dozen, or it may be for twenty, complete swings. The rate of swing depends upon the capacity of the charged body and upon the self-induction of the discharge path—corresponding to the yielding quality and the inertia of the bent spring—but in most electrical cases the rate of swing is prodigious; it is comparable in fact to a million swings a second, more or less. The vigor of such swings as these, if on anything like an extensive scale, is hardly to be wondered at. The waves into which the ether is thereby carved are long and quick-traveling ones; they travel with precisely the speed of light. Light indeed in one sense they actually are, but not such light as can affect our retina. They are too gross, and fortunate it is for us that they are so, for during the instant they last their intensity is tremendous and would blind us.

When an electrified body of any considerable capacity is discharged through a path of high resistance, the recovery is comparatively slow; the current lasts an appreciable time and the only noteworthy result is heat. The heat may be of sufficient intensity to make wires red hot or to ignite gas and gunpowder. In those surroundings it is dangerous; otherwise it may be considered harmless. But when a considerable electrified body is discharged by a good conductor, the rush is sudden, violent, and oscillatory. Much less heat is then produced on the spot, but the noise and light called an electric flash is developed. A violent shock can be felt by an animal coming into line with it, and out into space go those tremendous waves of which we have been speaking. These waves may simply spread out further and further into space, becoming weaker and weaker as they go, by reason simply of the extent of territory over which their fixed supply of energy has to be spread; but on the other hand they may encounter conductors, and set up in them, by a process analogous to "acoustic resonance," electrical surgings of sufficient vigor to produce sparks, or even to do damage. All this is true of the release of any store of static electric energy—of the discharge of any electrified body. It by no means ceases to be true when the charged body is a square mile or so of cloud. Not only are all the effects spoken of likely to occur then, but they may occur with irresistible and overwhelming violence.

No longer now can it be held sufficient to lead "the electric fluid" down to earth by the shortest and easiest path, as a rain-shower may be led down by gutters and water-pipes ; no longer can a copper rod, even several inches or a foot thick and as long as you please, be considered a thoroughly efficient protection. Experimentally it can be shown that when a discharge takes place even down such a rod as that, sparks may fly from it to all conductors near, even to quite insulated conductors which lead nowhere. Into space and out again the electricity springs ; and while it is thus flashing about the ramified conducting-pipes and wires of a building, woe be to the weak place, the explosive compound, or the gas-leak which it may chance to encounter. And even if side-flashes from the conductor itself do not happen to be dangerous in any particular instance, that is no safeguard against the furious though evanescent system of waves excited in the surrounding medium. These, as before explained, may excite sparks in perfectly detached and possibly distant conductors ; and though such sparks may be far too feeble to knock out bricks and mortar, every one who has used an electric gas-lighter knows how feeble a spark is sufficient to ignite escaping gas. Moreover, when the discharge has reached the earth the danger is not over. A region of earth is for the moment overcharged, and the charge rushes away as best it may, splashing and surging up in many unexpected places. I have seen a house whose only important damage was in its cellar, and it stood near a lofty church-steeple properly protected. I have little doubt that the damage was done by a portion of a flash which had reached earth in the neighborhood and was on its way to dispersion underground. Some obscure fires may be due to such causes as these ; more, perhaps, than have yet been suspected.

What then is the remedy? For important buildings, gun-powder-magazines and the like, there is no hesitation in the answer of modern science. They should be encased completely in metal, and no pipe or wire or anything metallic should be allowed to come through the walls or floor or roof without being itself metallically united to the metal sheathing at the place of perforation. That being done, and the sheathing being stout enough not to melt even at the place where a flash may happen to strike, everything inside is absolutely secure. No spark can be caused inside a closed metal cavity by anything that happens without. But inasmuch as the fierceness of a flash at its place of striking is very great, and such as few metal sheathings can with safety stand, it will be better to provide a projecting rod or two so as to tempt the flash to strike them ; for then the melting of the first foot or so will be of no consequence.

But science goes a little further in the direction of ease and practicality than the above counsel of perfection. It asserts that an open metal netting is quite sufficiently safe, except as regards regions inside but so near the boundary that their distance from the net is comparable to the width of its mesh. For ordinary houses, there is no need to be absolutely and mathematically safe. We never can fulfill such ideal conditions in this mortal life. If we should lock ourselves into caves in a copper mountain we might find there some lurking influenza germ capable of destroying us. For houses, then, a very open-meshed cage ought to suffice, and practically a wire along all the gables and down all the corners, with perhaps a few in between, especially on any prominent features, may serve well enough for all except for those who have an exaggerated notion of their own terrestrial value. Any metal serves equally well for the conductor; the cheapest and most infusible is best. Conductivity is ridiculously unimportant; durability is a much more serious matter. Points or projections to the sky are useful for the reason stated, namely, to take the violence of the direct flash at its point of incidence in a cheap and conspicuous manner. Earth connections are desirable to save the foundation, the soil, and the pipes therein from being knocked about. Sometimes one is inclined to recommend plenty of sky points, in the hope that a flash may be averted by their continual steady discharge. But I have lost faith in the discharging power of points when any large quantity of electricity has to be dealt with. Not until they begin audibly to fizz is any impression made on a large store of electricity, even by hundreds of needle-points; and, as soon as fizzy or brush discharge begins, small knobs, jagged edges, and the hundred other irregularities about a building are about equally effective. A smooth-polished dome is certainly not a desirable finial, but any ordinary roof-top should supply plenty of brush-discharging corners, especially if it is well connected to the earth by frequent iron wires. Circumstances sometimes occur, however, when the spears of an army would be incompetent to avert a flash; it is necessary to be prepared to meet it when it comes, and wise to admit the presence of a slight residuum of danger, even when every precaution has been taken to grapple with it effectively. Fortunately a building cannot often be thus dangerously struck without all its inmates and all neighboring inhabitants being aware of the fact; and I conclude that a desirable precaution would be to have cellars and floor-spaces and every place likely to contain gas-pipes or other inflammable material, inspected immediately after such an occurrence. Nor should the person in charge of an important building rest secure until a sufficient lapse of time has rendered it unlikely that any minute ignition may be gaining headway in some obscure and inaccessible region.

I have thus degenerated into practical aphorisms, about which there may be some difference of opinion. In all I say about what people should or should not do, I of course would be understood as offering suggestions. Every one sufficiently instructed in the new facts of the science is competent to decide for himself what his procedure shall be ; and many persons, like myself for instance, will probably be satisfied in feeling that they understand the circumstances fairly well and are not going to trouble themselves to do much to increase the safety of their houses. But then, with us in England, storms are rare and usually gentle. In South Africa, in the United States I suppose, at many cable-stations certainly, they are far otherwise. Hence the lightning-rod-man has been able to make himself a nuisance in such localities. With us he is scarcely known as a pest. The business seems to be in the hands of a few dignified firms who do not " tout " for custom. Long may it so remain : I trust that nothing I may happen to say will make it otherwise. It is, however, well to grasp thoroughly the conditions of a practical problem before setting to work to solve it, and if these firms can see their way to altering their procedure little by little, a better system of protection can be achieved without any revolution. Plenty of iron wire instead of a single copper rod—that seems to summarize what is required for ordinary buildings. For extraordinary buildings—explosive magazines, telegraph-cables, and telegraph-stations generally—a good deal more has to be said ; and concerning telegraph-stations in particular there are a good many details to be gone into.

Some of my scientific statements may sound arbitrary, but they are not really so ; they are not infallible of course, but they are based on good evidence. One of them which may sound rather revolutionary, and which indeed is rather revolutionary, being quite opposed to the views of Franklin and of Faraday, is the one which asserts that conductivity in a lightning-conductor is quite unimportant. One is not to go to the absurd extreme of supposing that therefore a rod may be made of glass or wood. Its meaning is that such difference of conductivity as exists between different metals is entirely unimportant. The only significance of conductivity is to avoid destruction by heat, and even in this matter, oddly enough, a bad conductor has certain advantages. A good conductor allows less time for the heat to escape ; it may even get more heated than a bad one, because it can convey a stronger current. A non-conductor, for instance, whatever else might happen to it, would certainly never get *melted* by an electric current. As regards the easy conveyance of a violent flash, conductivity has nothing to say. The obstruction which an alternating or rapidly-varying current meets with is not the reciprocal of conductivity known as ordinary electrical resistance. It is not a bit like any resistance or anything analogous to friction : it is an obstruction of a totally different kind, closely allied to inertia.

A well-greased railway-truck may be pushed along by a boy when it is once in motion on a level line, but try to get it in motion, or to stop it, by a sudden blow, and, though you may knock the truck to pieces, you will not make much other impression on it. Electricity, in this respect, behaves like a substance with a great deal of inertia. Speaking popularly, to set all the electricity in a stout copper conductor into motion by a sudden force is a thing not to be done without violence. The force of lightning is indeed sufficient, but the violence of it is excessive, and, from every part of the rod subjected to lightning, electricity spurts as if a column of water were struck with a steam-hammer. This immense inertia obstruction, quite different from frictional resistance, and non-existent to steady and long-continued forces, has lately received the name "impedance"; and it is desirable that the cultivated world should get accustomed to the thing, whether by this name or by some other.

I spoke, a little way back, of inertia as being the cause of the prolongation of a discharge into oscillation. It is also the cause of the extraordinary obstruction which even a perfect conductor offers to sudden electromotive forces—an obstruction not many times less than that offered by a corresponding air-space, especially if the air be hot; so that when a discharge has begun to strike down a stream of hot air, for instance the current rising vertically from a factory-chimney, it is not easily diverted to a lightning-conductor projecting from the side of the chimney only a few feet away, but may prefer to continue its path down the air-column unless it is intercepted by some metal hoop or branch conductor thrown right across the mouth of the chimney.

In the light of such facts as these it is obviously absurd to speak of "areas of protection" or to think that one easy path protects all others in its vicinity. The fact is that to make an easy path is impossible; all paths offer a great obstruction to sudden currents, and many paths are therefore liable to be called on to convey a portion of the rush. Elaborate testing of the minute resistance which lightning-conductors offer to feeble voltaic currents is quite useless. It is worse than useless, because it is misleading. It is like trying to predict the course of an avalanche by trickling a pailful of water down a hillside.

Such is the outcome of some recent electrical investigations; and the result may be said to constitute the first distinct advance in this particular branch of applied electrical science since the time of Franklin.

RECENT ARCHITECTURE IN PHILADELPHIA.

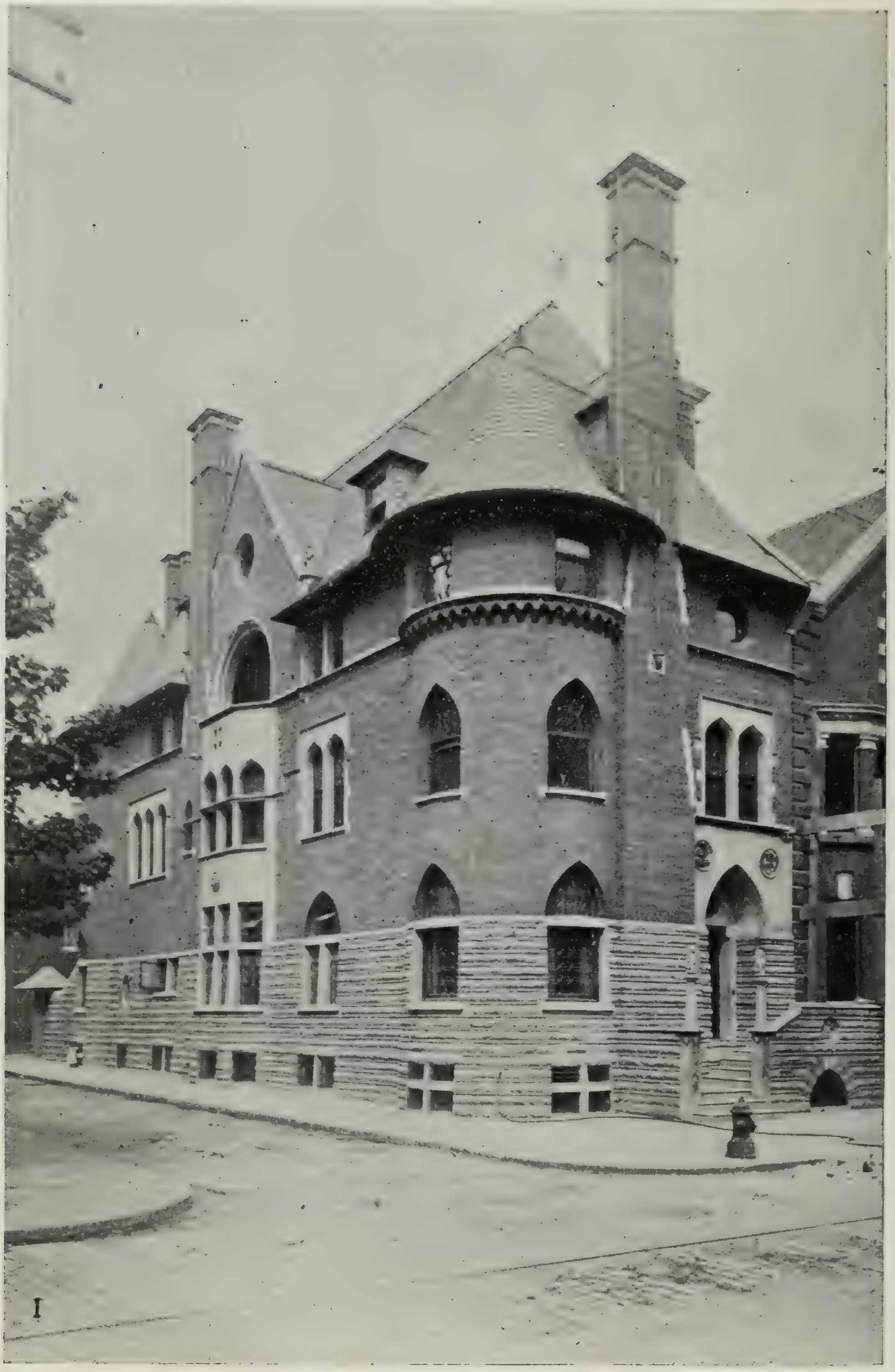
By Prof. Warren P. Laird.

IN its architectural aspects the City of Brotherly Love presents one of the most interesting if not inspiring fields of modern American practice. For it contains some of the best as well as much of the worst of American architecture, in both phases of which is to be found, perhaps, a stronger expression of individuality than can be presented by any other large city in this country. So much has been heard of the badness of Philadelphia architecture, and so often have its artistic transgressions been held up for contemplation, that it has become the writer's pleasant duty to present to the readers of this Magazine the other side of the picture and to ask their attention to some phases of professional work which are in the highest degree excellent. This is done the more willingly because the critics would have us believe that, moral law to the contrary notwithstanding, one thing at least in this world is wholly bad, and that is Philadelphia architecture.

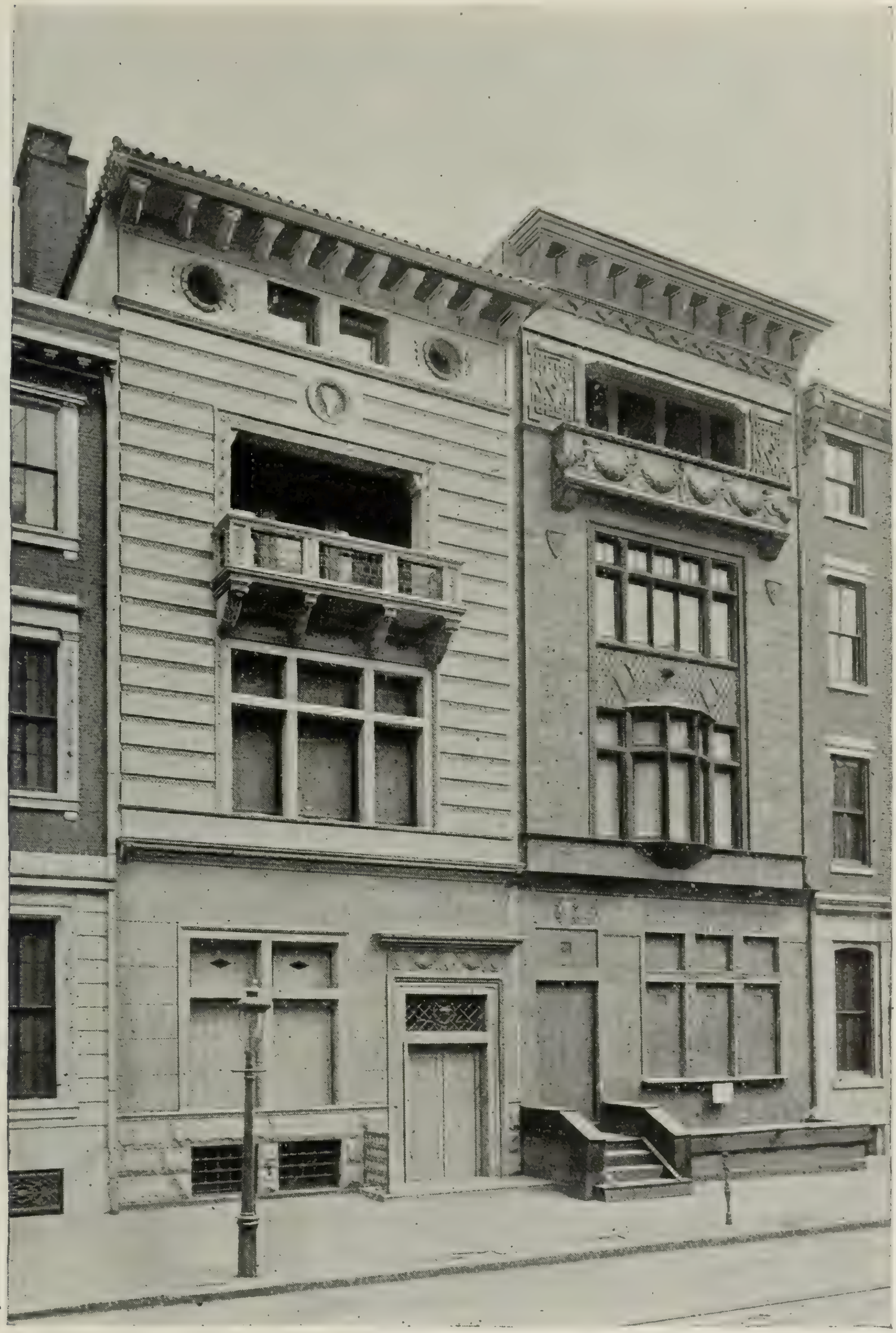
Many and grievous are the architectural sins charged against this well-meaning community. We are to believe that no principle of composition, no precept of history, no canon of taste nor law of æsthetics is respected by it. The critic exhausting other fields, turns again and again to this, always finding fresh material for his strictures, and never wearying of the apparently hopeless task of doing justice to the subject.

The critic is right—in the main. Yet he is wrong in one very important particular. Were it not for the cheering fact that he is usually blind in one eye, we would be forced to believe Philadelphia the architectural Sodom he paints it ; but we know that his vision is restricted, and that he has not seen the good because of the bigness and boldness and frequency of the bad.

The strangeness of present characteristics in the building art of Philadelphia is not strange in origin. Yielding tardily to the widespread movement which has so completely changed the character of her sister cities during the past thirty years, and with a reluctance most becoming in a town of such conservatism, she has in a few years undergone a change that is scarcely less than a transformation. And to the fact that the change has been so sudden and so radical may be ascribed those characteristics that make the city an interesting study. For nowhere else are there such strange contrasts, not only between old and new, but between the different phases of new work.

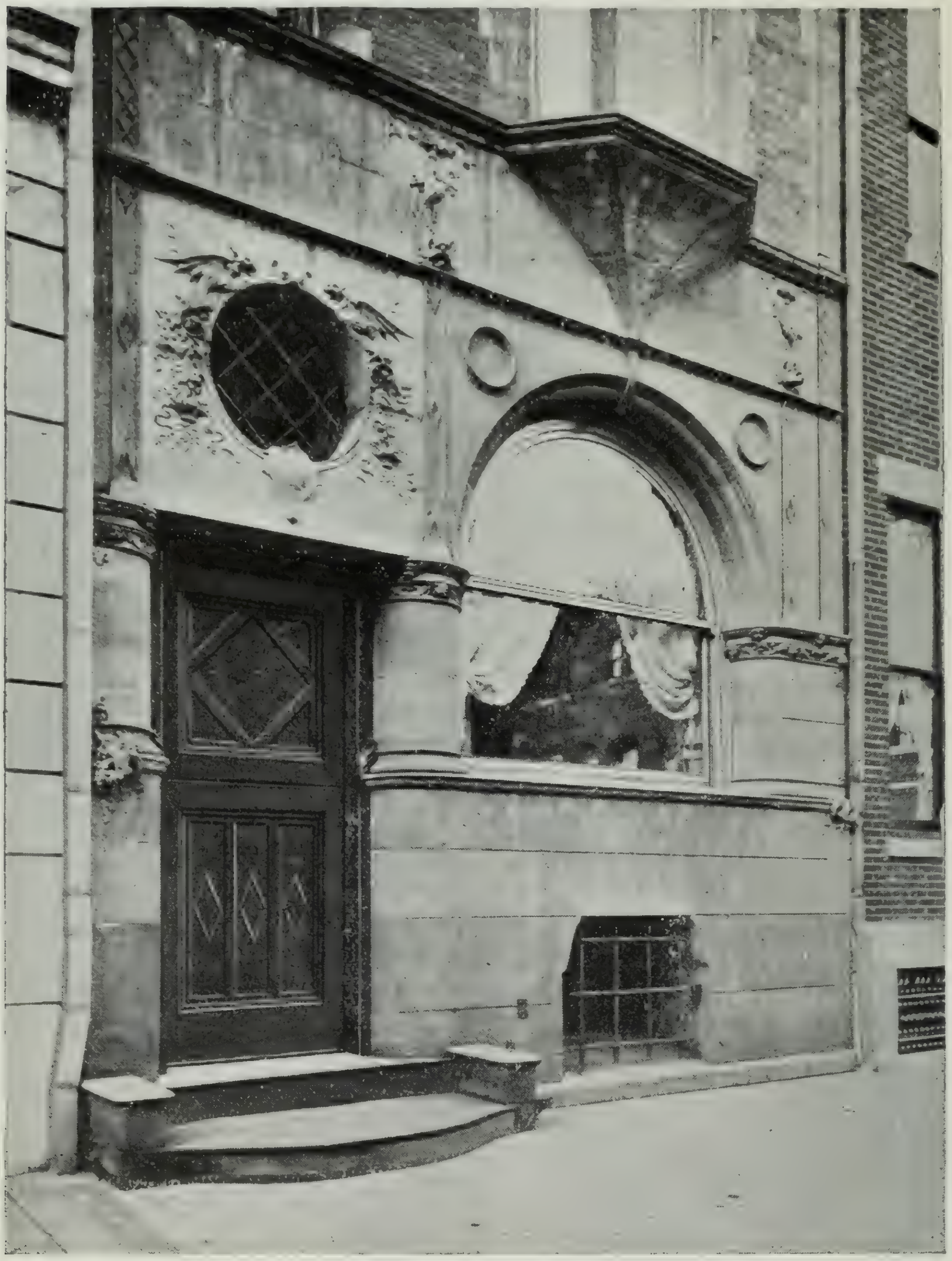


HOUSE AT JUNIPER AND LOCUST STREETS.



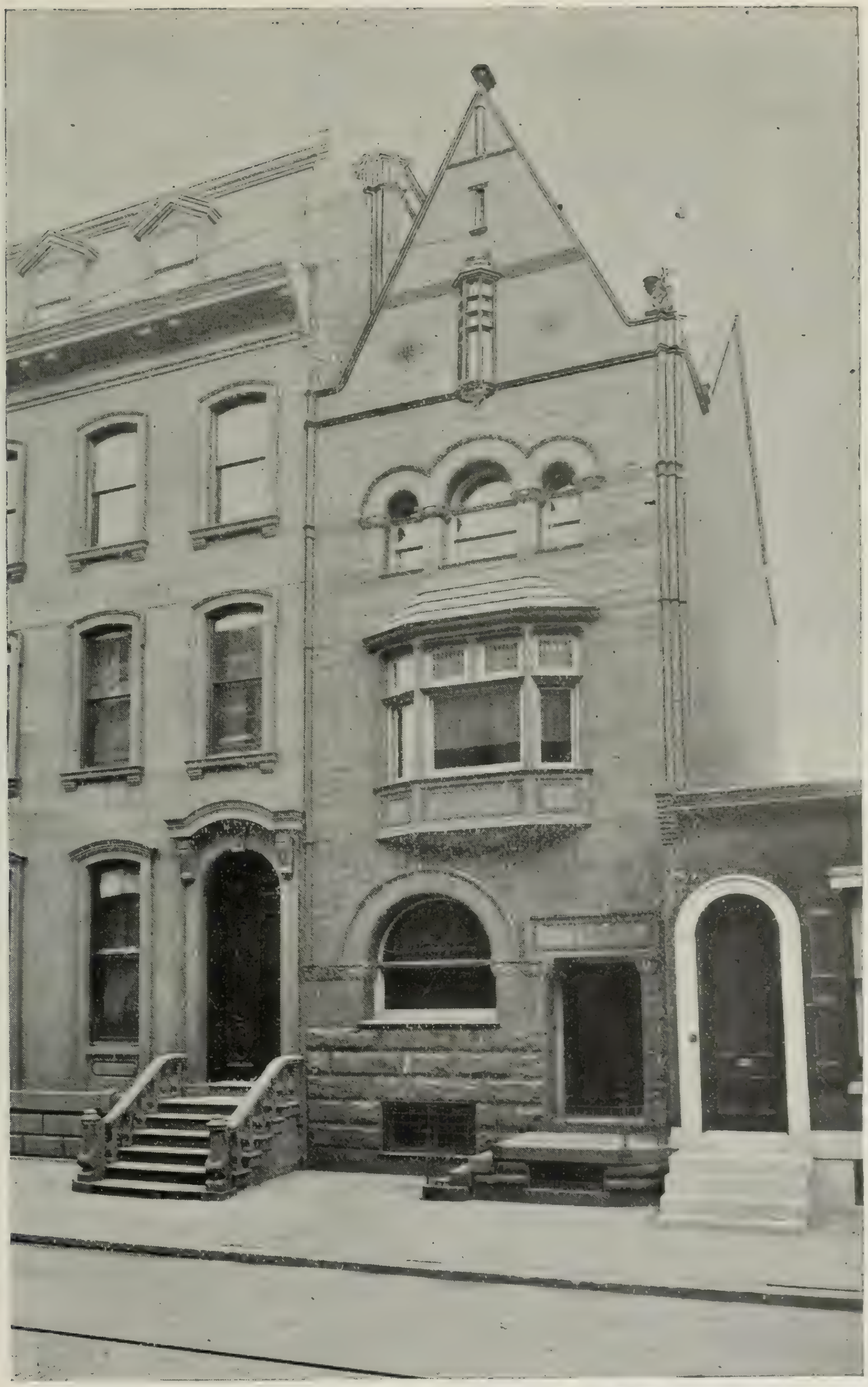
TWO HOUSES ON WALNUT STREET ABOVE SEVENTEENTH.

The ambition of the older Philadelphian, while it may have permitted him a house larger than that of his neighbor. never suggested to him that it look unlike it. In consequence, his city became proverbial

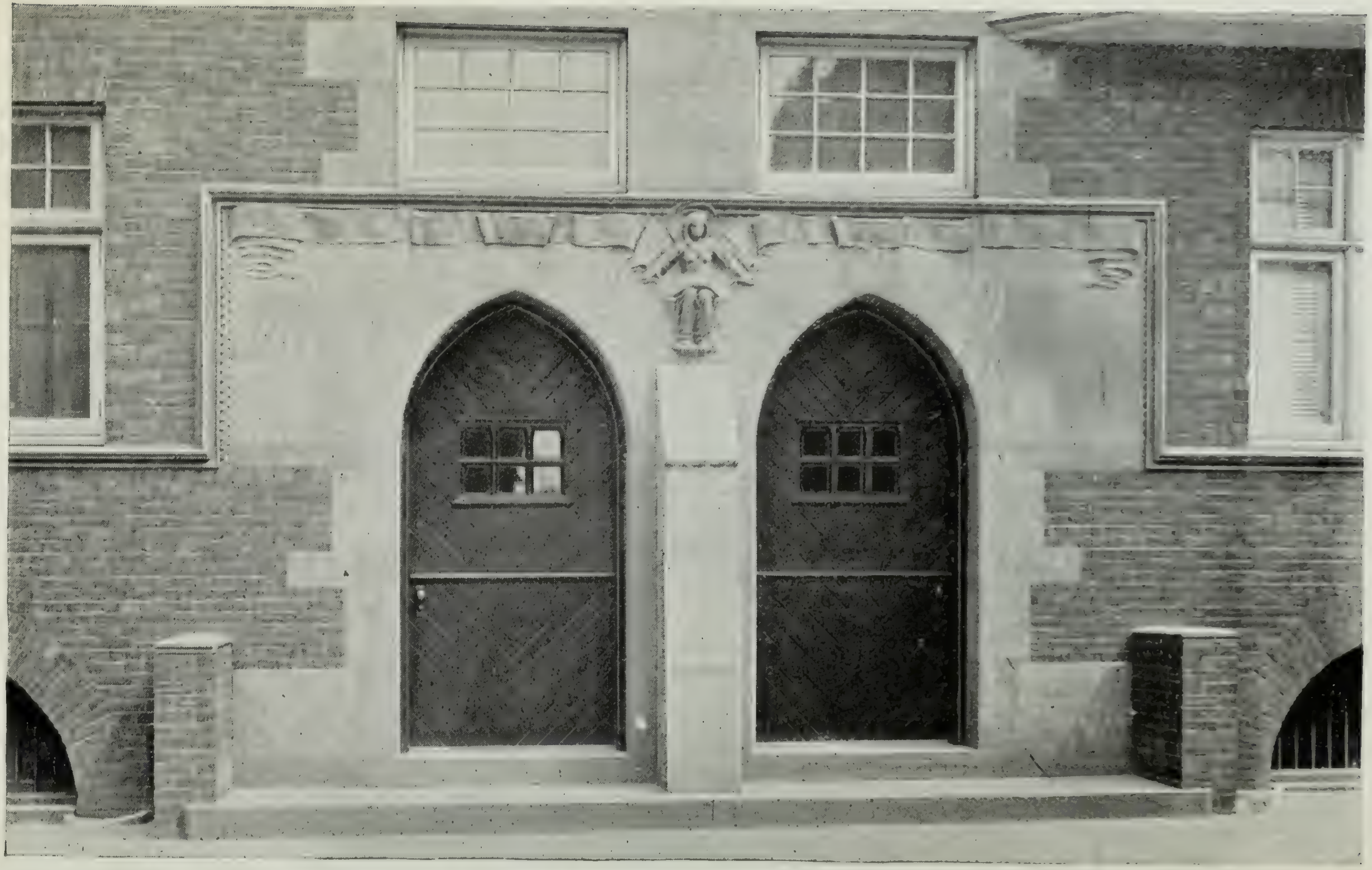


LOWER STORY, WALNUT STREET, NEAR SIXTEENTH.

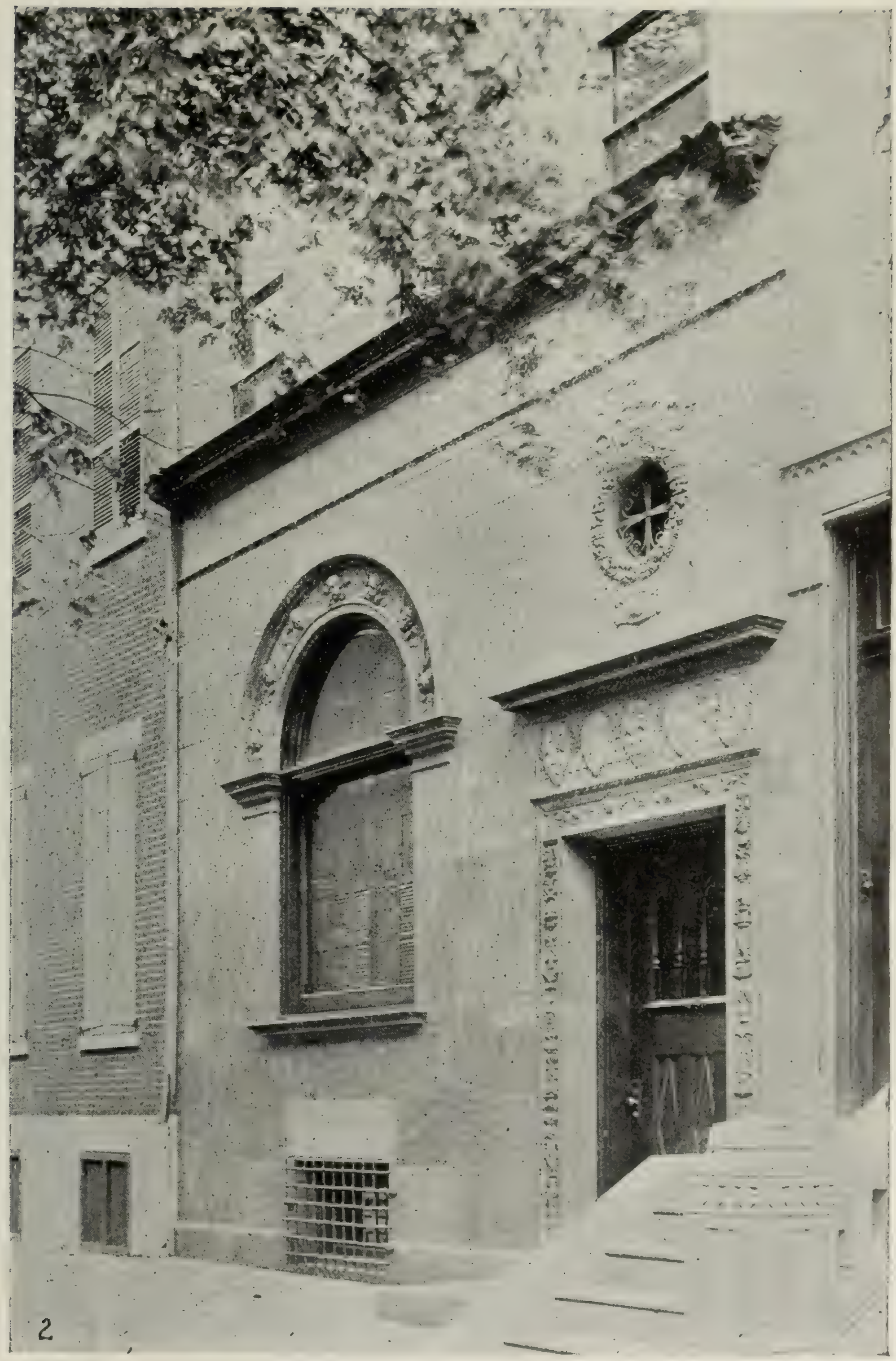
for its monotonous uniformity—its miles upon miles of red brick fronts with white marble trimmings. But no surrender is so complete as that of the most obstinate fighter when once driven from his position, and Philadelphia conservatism has given way, as before a flood, to a feverish desire for novelty and variety. Scarcely can any two buildings be found to resemble one another ; and in all this marvelous variety may be found illustrations of every stage through which American architecture



HOUSE ON WALNUT STREET NEAR TWENTIETH.



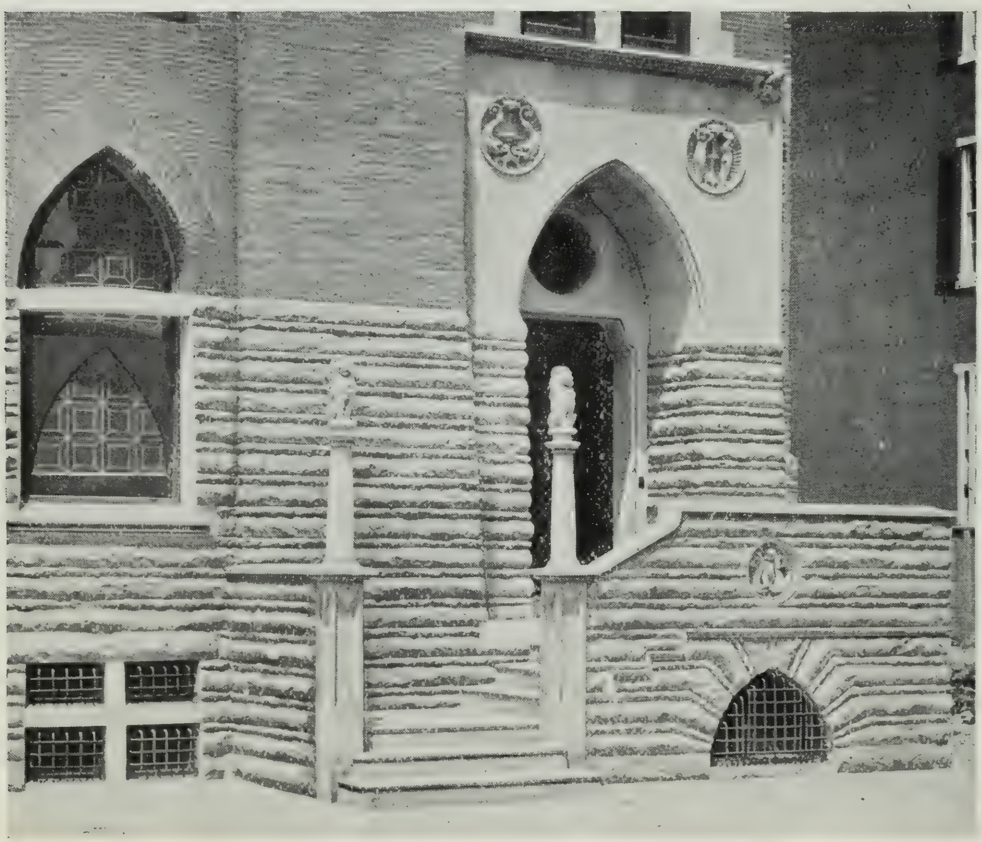
ENTRANCE TO DOUBLE HOUSE ON SOUTH TWENTY-SECOND STREET.



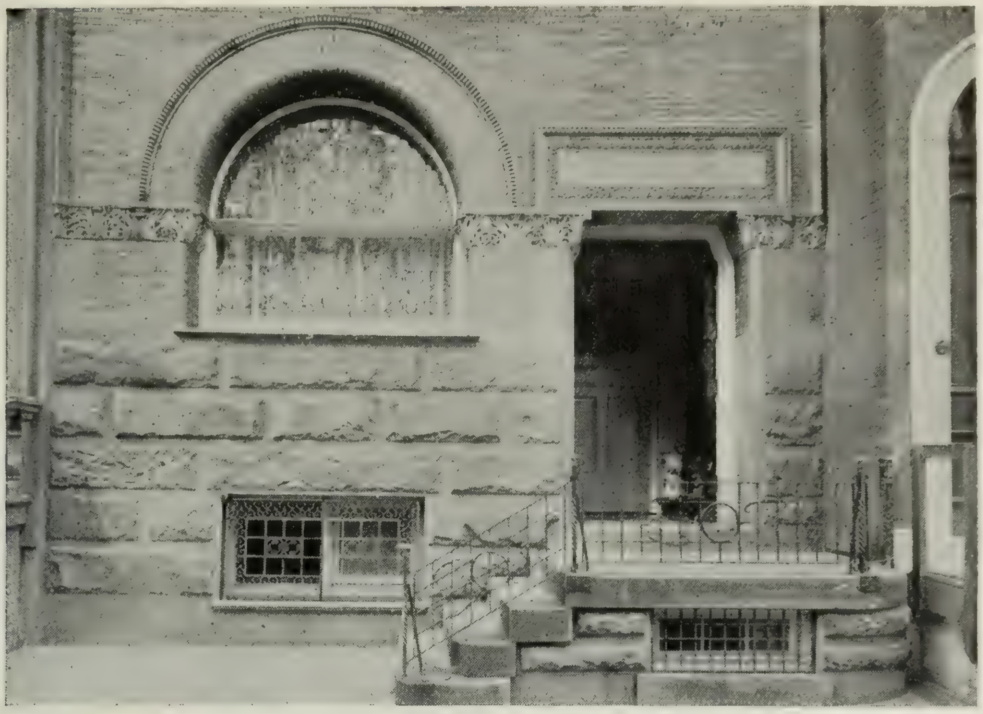
A NEW FRONT ON SPRUCE STREET NEAR FIFTEENTH.

has passed during recent years. Indeed, it may almost be claimed that Philadelphia is at once the most curious, the most typical, and the most instructive of American cities;—curious because of the strange medley of its more pretentious buildings, and their singular and often eccentric individualism; typical of American practise in its broadest aspects because of the absence of restraint and defiance of precedent shown by the great majority of its architects; and instructive because of its contrast, for no other American city has so wide a field of architectural error to offer in contrast to its works of real merit. Thus it is that Philadelphia architecture is more heterogeneous, more varied, and more open to criticism than that of any of the other large cities of this country.

More than in any other large city has the individual architect shown his hand in Philadelphia; and less than in any other has any coalescence shown itself among the separate influences that have made its architecture. But within a very few years a distinct movement has been manifested in the work of a small group of architects which, while not lacking in originality and individuality, has at the same time been marked by a uniform refinement, purity, and intellectual quality that placesit entirely apart from the conflicting and misguided elements among



ENTRANCE, JUNIPER AND LOCUST STREETS.

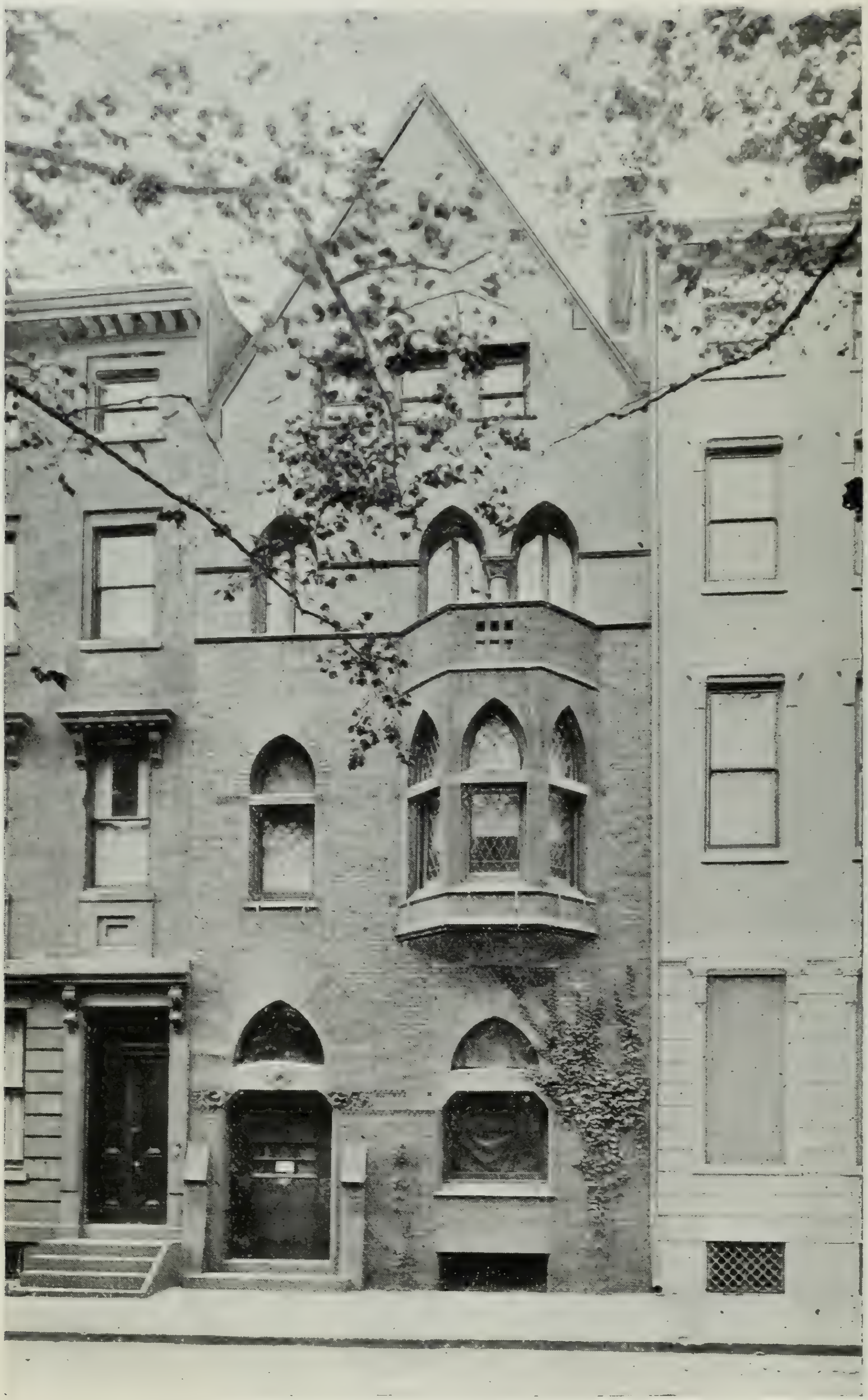


LOWER STORY, WALNUT STREET, NEAR TWENTIETH.

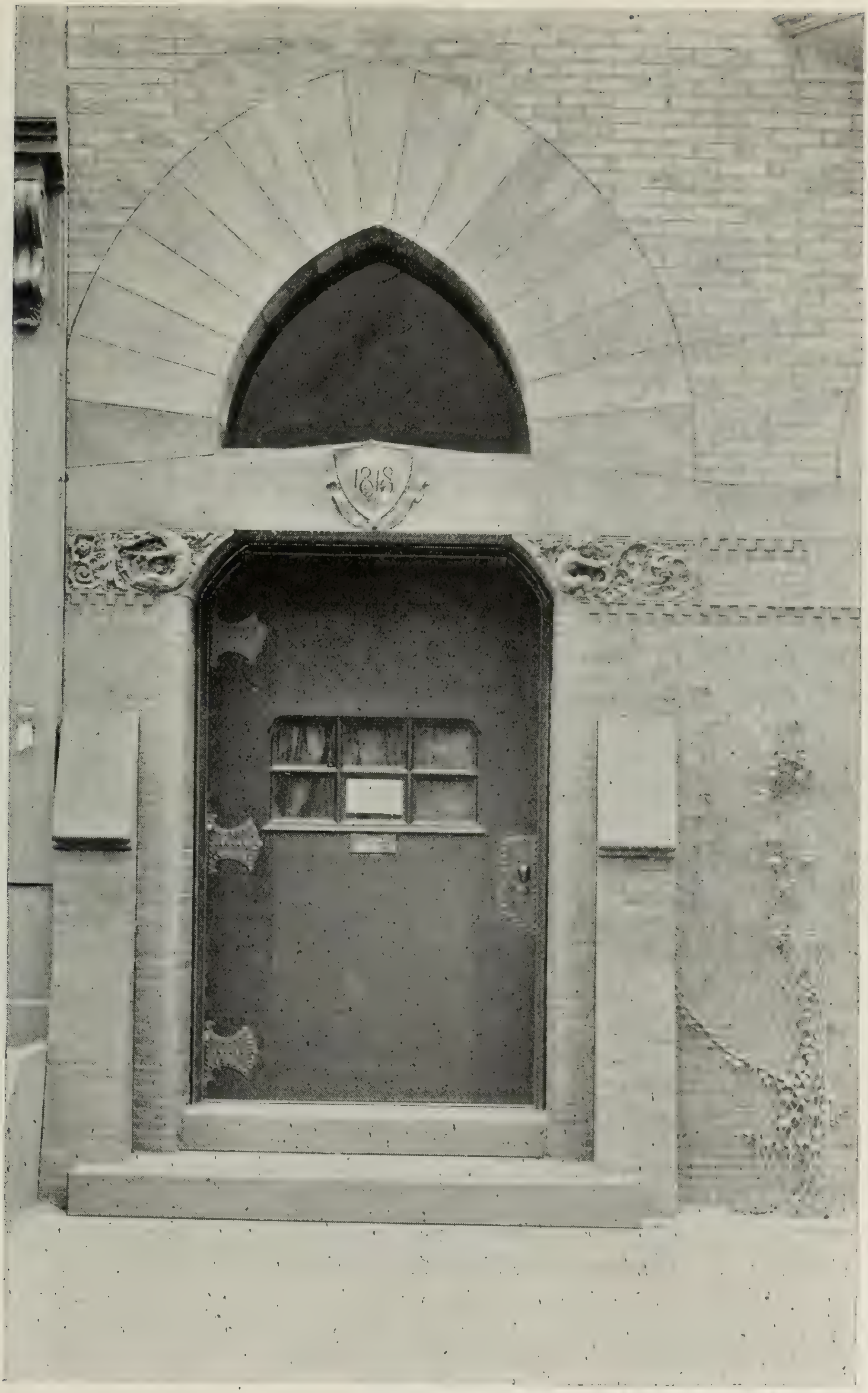
which it has forced its growth. It has not shown itself obtrusively, and is not to be found among the more conspicuous buildings ; for here, again, Philadelphia differs from other large cities whose monumental architecture is frequently their best. Very seldom is it the case that prominence in a Philadelphia structure does more than make failure conspicuous. The best of recent work is to be found among the less pretentious buildings, and the greater portion of it exists in dwellings. It is noteworthy that the City of Homes should have begun its architectural reformation in this class of buildings. If, as we may believe, his home is the subject upon which the Philadelphian feels most strongly, then the seeds of reform could not have been more favorably planted.

The illustrations will be found to present broadly, the best of the recent work among dwelling houses. Several types are displayed ;— the usual narrow city front, the corner house, the semi-detached house, and the suburban dwelling. All are conformable to the usual requirement of city house planning, and in none has advantage been taken of unusual conditions to secure given effects in external treatment.

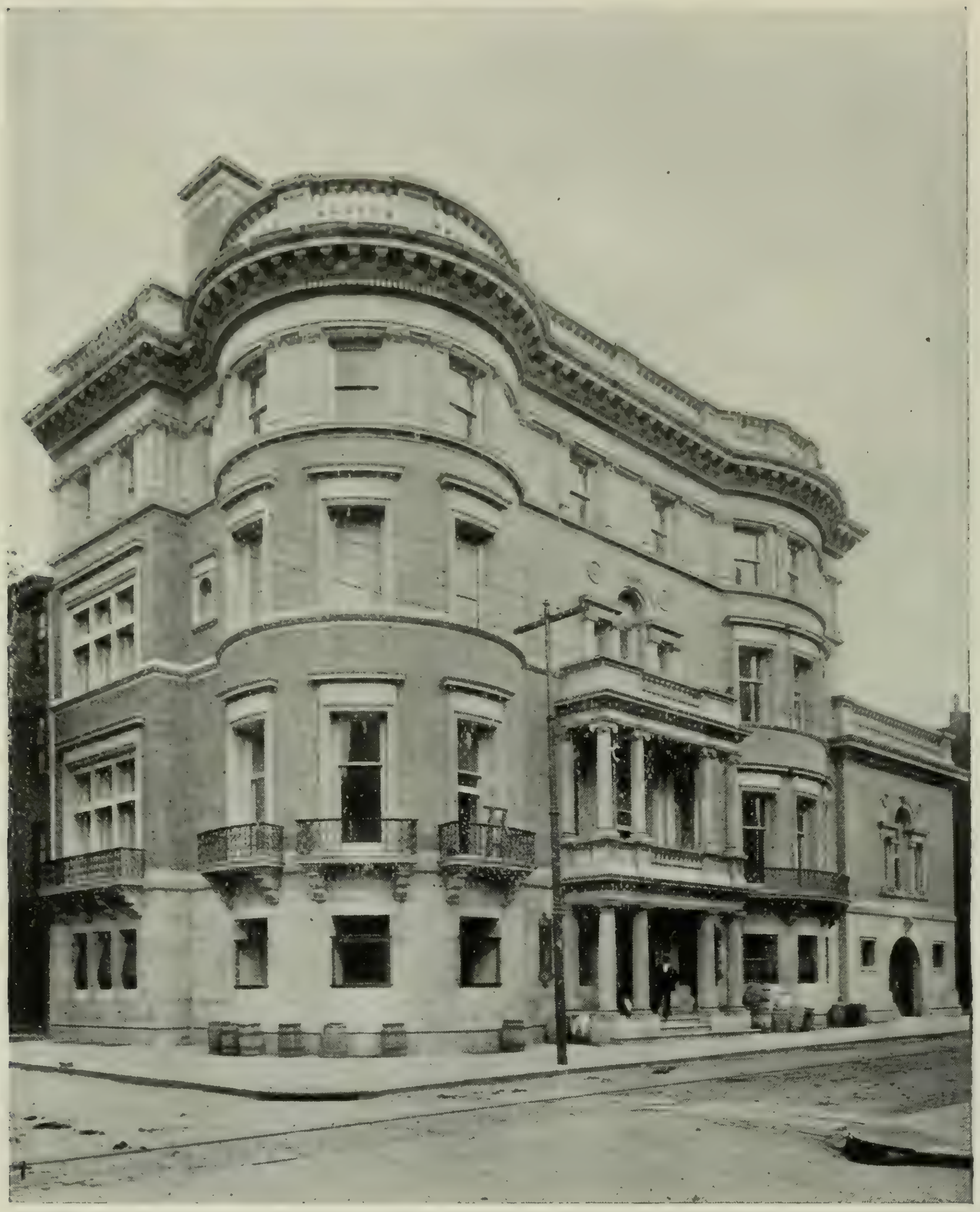
The house at Locust and Juniper streets is a singularly successful attempt at picturesqueness in a city house. The result is attained by simple means, and the whole effect is one of quietness and restraint ; yet an unusual freedom in play of line and surface is everywhere evident. A nice balance in expressiveness is maintained between the formal and dignified character expected in a town house and the in-



HOUSE ON SOUTH RITTENHOUSE SQUARE.



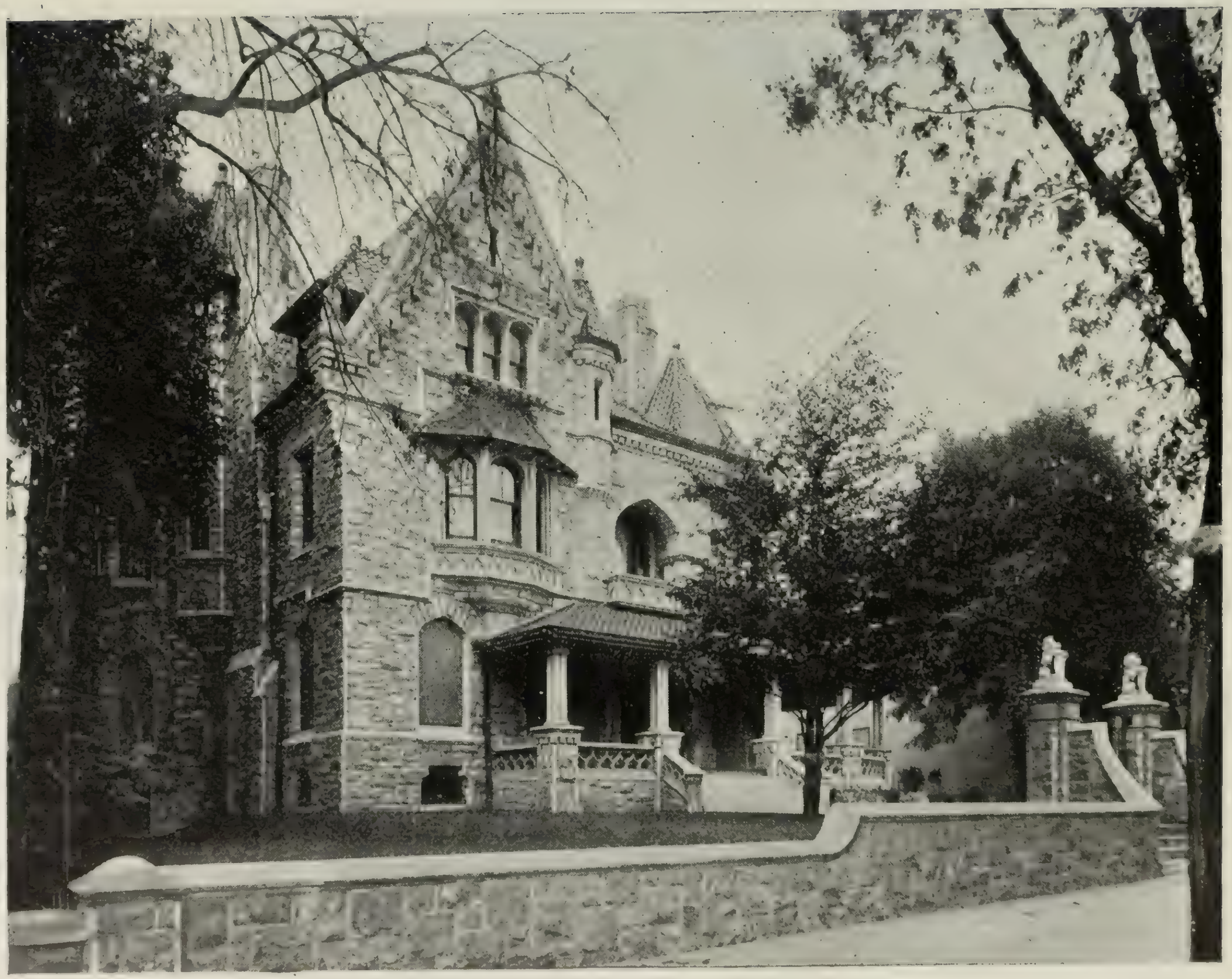
ENTRANCE, SOUTH RITTENHOUSE SQUARE.



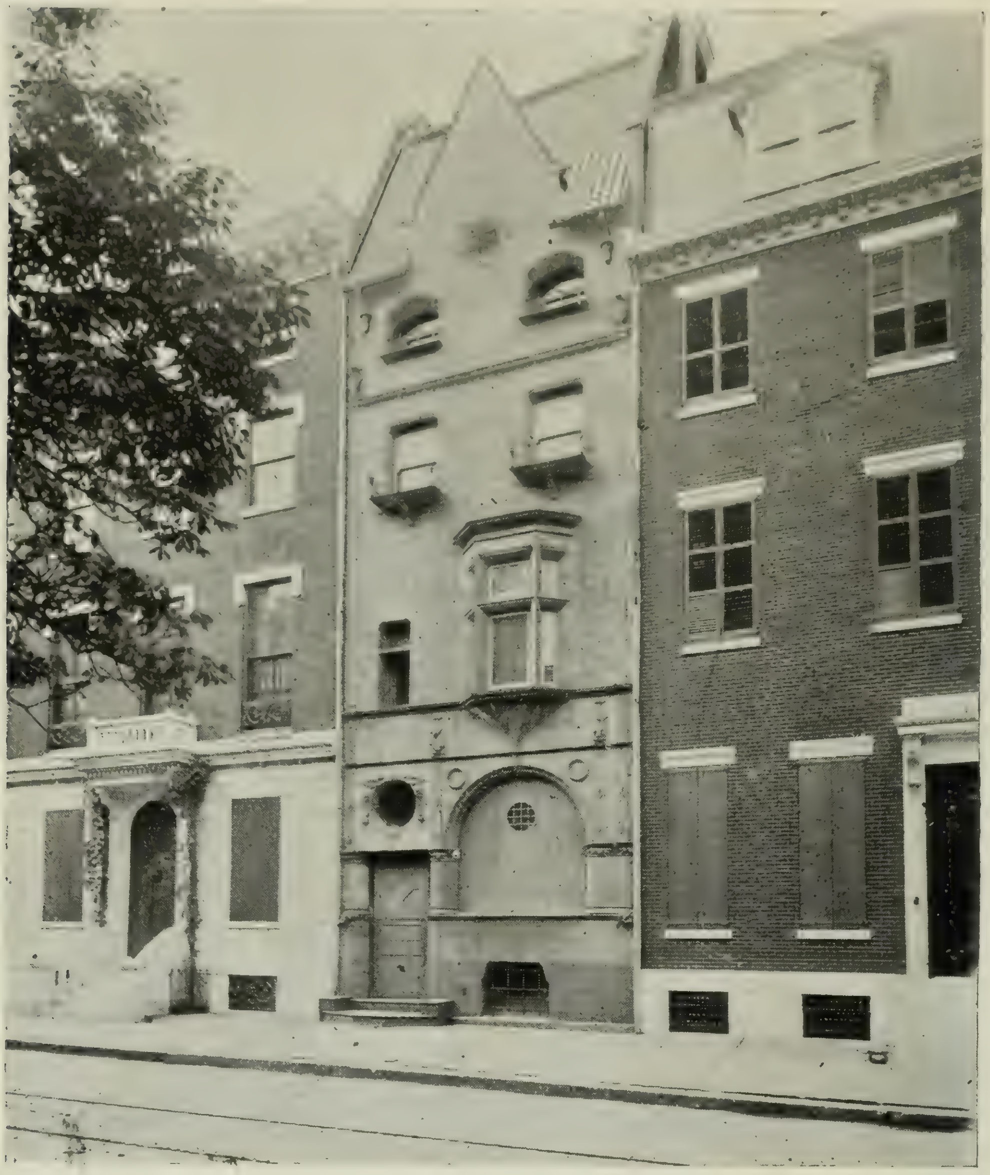
HOUSE AT LOCUST AND SIXTEENTH STREETS.

formal and domestic nature of a house, and this solution of one of the most frequent of problems in an architect's practice is as charming as it is unusual.

Problems of a very different nature evidently confronted the designers of the two houses on Walnut street above Seventeenth. Placed upon lots scarcely wide enough to permit of more than one room at front in the upper floors, they seem to demand treatment expressing such an arrangement in the plan. To secure this a single *motif* has been taken as the keynote of the composition, in both cases, and a



HOUSE ON CHESTNUT STREET, WEST PHILADELPHIA.



HOUSE ON WALNUT STREET NEAR SIXTEENTH.

consistently simple division of the masses, vertically, adopted for its groundwork. Though differently treated in either case the Italian Renaissance has been successfully employed in both designs, not only in the detail but in the broad cornices, the *loggie* and the fenestration, indicating an earnest and sympathetic study of the style and an intimate knowledge of its spirit and its forms. In a problem of this nature, where the composition is resolved into few and simple elements, the adoption of a style which so readily adapts itself to a broad and simple treatment leaves to the designer a restricted field for the exercise of his skill, permitting little more than the proportioning of voids to solids and the judicious application of ornament. Within such limits both these houses are admirably handled, that to the left being especially pleasing, while the detail in both cases is exquisitely wrought and applied with the greatest judgment.

Less pure in style, though carefully studied and full of character, are two other houses on Walnut street, one below Sixteenth and the other near Twentieth. The latter is an essay, in so far as features and details are concerned, in Romanesque, though treated with less vigor than usual in that style, as befits the outward and visible signs of a quiet domicile ; while the former has a pleasing ground story in Early French Renaissance. Neither of these houses is large and both are treated with quiet refinement.

Two houses in which the entrance has received distinguished consideration are those of a semi-detached house on South Twenty-second street, and a private dwelling on Spruce street near Fifteenth. In the double house the equal importance of the two doors is frankly expressed in a symmetrical treatment of simple forms and broad surfaces. The chaste simplicity of the composition, with its single piece of well placed sculpture, has a rare charm, augmented by the harmonious character of the arches, the reinforcing buttress and the draperies of the figure. Widely different in its inspirations and its frank deference to historic precedent, though equally sensitive to proportion, is the first story of the Spruce street house—an alteration. This charms us, not through originality, but by the fidelity of its details to their Italian prototypes and the almost equally clever adjustment of the several parts to each other and the whole, which the designer's sense of proportion has alone supplied and any failure of which would but have been exaggerated by the beauty of the details. No more perfect expression of refinement than that given in these two entrances is to be found in the architecture of Philadelphia.

The dwelling on South Rittenhouse Square will repay close study. Its northern frontage, like that of several others of the buildings under consideration, deprives it of that most lucid of interpreters, sunlight, and this disadvantage is further heightened by the light-absorbent character of its material, Pompeiian brick and red sandstone. It conforms closely to the usual conditions imposed by city building laws and is, further, unsymmetrical in internal arrangement, as indicated. These are the usual conditions and limitations of a city house problem in an architect's hands, yet the usual result is either no design at all or a very bad one, while this on the contrary, has been rarely successful. If we examine the design, accepting the conditions of height and narrowness as imposed upon the architect we feel that the vertical divisions are rightly placed and properly marked, the line being felt at once yet being none too strong. The features are in themselves well proportioned, are expressive of the relative importance of the rooms they mark, and are correctly related to each other and to the general mass of the building. They moreover clearly express its unsymmetrical internal divisions. Simple to an extreme, the ornament is placed where it counts for most, the moldings giving a clear, firm line, and the carving accenting the points most justly demanding it.

Every detail and every line bears evidence of careful and loving study, even to the just perceptible curving of the oblique sides of the bay. Taken as a whole, while simple to the verge of severity, the composition is one showing rare sense of proportion and the greatest refinement and delicacy of handling. The style in which it is composed and the spirited individual treatment with which it is carried out to the last detail give the whole design a rare charm of novelty and freshness. Without a commonplace feature and yet without any evidence of a striving after originality for its own sake, this building is not only very original, but is an exceedingly fine piece of composition.

This entire group of houses, with others of their kind, stand apart from the generality of Philadelphia buildings, both for the sense of proportion and harmony displayed in their composition and for the refinement and purity with which they are treated. Whether historic precedent or its spirit and intent alone is selected as the keynote for treatment, the result shows a scholarly knowledge and a high artistic appreciation of both. In this spirit and this only is the salvation of Philadelphia architecture to be worked out.

But the list of our more noteworthy buildings is by no means complete without reference to the handsome structure now under completion at the corner of Sixteenth and Locust streets. The style in which it is conceived has been so often employed that originality or even freshness of treatment is perhaps impossible, but those qualities which it is so well calculated to express, dignity and elegance, are well presented in this instance. The composition would have distinctly gained in dignity and repose had the front wall been left without its rectangular projection, and the proportions, though generally excellent, are somewhat jarred by the too prominent sill course under the third story windows, and by an over heavy cornice. Although strongly suggestive of a well-known Boston mansion, it is yet possessed of sufficient individual excellence to entitle it to high commendation on its own account.

Another house worthy of special note is that on Chestnut street above Thirty-ninth, in West Philadelphia. Worthy, not for any single virtue of unity—of masterly grouping of parts, but because the tendency it shows, in common with other work mentioned in this paper, toward the scholarly appreciation and skilful use of historic forms under the limitations of modern practice. This is shown more in the minor portions of the structure, whose forms and details are designed and executed with great truth and spirit. Although the design bears evidence of want of study, its main lines are well conceived and many portions yield happy effects to which any single view of the building can do justice only in part.

As it is manifestly impossible to show in a single illustrated article every example of the best recent work, the dwellings of Philadelphia are selected for illustration as embodying greater excellence than any other class of buildings. But the same general degree of excellence is found in a number of smaller club houses and store buildings, while distinct success has been attained in several churches, as for example in the exterior of the Tabernacle Church at Thirty-seventh and Chestnut streets. Philadelphia has produced much deplorable work and her tendency has seemed to the outside world to be altogether a downward one in matters architectural. But this is an error. So long as she is possessed of the influence of combined talent and taste which is making itself more and more strongly felt with every year, her streets will steadily improve in artistic character, and may at no distant time become attractive even to the visiting critic.

PROBABLE EVOLUTION OF THE ELECTRIC RAILWAY.

By Irving Hale.

THE development of the electric street railway has been so rapid, its acceptance by the public—except in a few of the largest and least progressive cities,—as the best system of rapid transit yet devised is so general, and the history of its triumph in the face of bitter prejudice and opposition is so fresh in the minds of all, that it would be a waste of time to discuss this branch of the subject.

The question of greatest interest to the public now is, "What will be the probable extension and limits of the application of electricity to railroading, and to what extent will it replace steam?"

It may be laid down as a law almost certain of fulfillment, that the development of the electric road will be a gradual evolution. This does not necessarily mean that it will be slow,—for that is a word supposed not to exist in the electrician's lexicon,—but that, like the growth of almost every other application of science and engineering, it will be a step-by-step process. This law was illustrated by every historical exhibit at the Columbian Exposition. In the chart showing the relative sizes of the Cunard ocean steam-ships from the *Britannia* of 1840 with a length of 207 feet, and engines of 740 horse-power, to the *Campania* launched in 1893, with its length of 600 feet, and engines of 26,000 horse-power, the gradation is almost as perfect as in a regiment on parade. In the exhibit of locomotives, from the John Bull and DeWitt Clinton to the famous No. 999 of the Empire State Express, with its record of 112½ miles per hour, few of these machines showed any radical departures in design or size from the types immediately preceding. There is no reason to suppose that this law will be departed from in the growth of the electric road, or to hope that any miracle of long-distance high-speed electric transit will spring in a state of perfection from a single brain, or become a complete practical success in a single year.

One of the first and most natural outgrowths of the electric street railway will be the application of electricity to elevated roads. In many respects this is an easier problem than the operation of surface roads, for the elevated structure affords an opportunity to conduct the current by a third rail, which cannot be satisfactorily insulated on a street track, and the motors are not exposed to their worst enemies, sand, mud, and water. In fact, some of the earliest experiments in electric railroading were made on the New York elevated roads, and the lack of complete success in these trials was due, not to any inherent weakness in electric traction itself, but to the fact that they were made when no really successful system, even for street-roads, was in existence. Now that the success of the Intramural Electric Road at the Columbian Exposition has demonstrated both the practicability and the advantages of electricity for elevated roads, there is no reason why the electrical equipment of such roads should not make rapid progress.

On underground railroads the advantages of electricity over steam are much greater than on surface roads. Steam-power, with its attendant smoke and noxious gases, is manifestly unfit for such service, and electricity is practically the only suitable power now available. The success of the London underground electric road leaves no question as to the practicability of this system, and its extensive adoption in the great cities of the civilized world may be confidently predicted.

Another natural extension of the electric street railway is the suburban and inter-urban road. The former is an established institution. The latter is already in operation in several places and will gradually extend its field of usefulness. The advantages of electricity over steam on roads joining neighboring cities are evident,—avoidance of smoke and cinders, more frequent though smaller trains, and the ability to make the street tracks of each city and the road between them a continuous system, avoiding the transfers and delays at the steam railway stations. Beyond comparatively short distances, however, the ordinary 500 volt system becomes alarmingly expensive and the need of some longer-range method is apparent.

This brings us to the long-distance electric road, which, because it is a thing of the future and is fraught with such alluring possibilities, constitutes the most attractive branch of the subject.

At the outset of the discussion, the inquiry is naturally suggested as to what can be gained by substituting for the locomotive, in which steam power is produced on the spot and applied directly to its work, a costly and complicated system consisting of a stationary steam plant costing more than the locomotive, electric generators costing about as much as the steam plant and wasting eight to ten per cent. of the power in the process of conversion, expensive line-work or storage batteries (according to the system used) wasting another fraction of the power, electric motors on the cars exceeding the locomotive in cost and causing a loss of another ten per cent.,—all this for the doubtful privilege of running our trains by electricity. There must certainly be some strong compensating advantages to justify such a proposition.

In the first place, power can be produced much more cheaply in a stationary plant consisting of compound condensing engines supplied by boilers of the most efficient type equipped with automatic stokers and grates for burning cheap slack coal, than in a locomotive where economy of fuel and labor must be sacrificed to economy of space.

Another advantage is the probable saving in repairs. The repair account for a locomotive, with its many rapidly moving parts and its overworked, poorly protected boiler, is a serious item. The electric motor with its single moving part, "iron-clad" method of construction, and thorough insulation of armature and field coils, is a very satisfactory machine from the repair stand-point, even when subjected to the trying conditions of street railway service, and in regular railway work, where it can be much better protected and cared for, there is little question of its superiority in this respect over the steam locomotive.

From an engineering stand-point, one of the most important advantages of electricity is the facility with which the weight of the car itself and its load of passengers can be placed upon the wheels to which the power is applied, thus utilizing this weight to give the necessary traction. The problem of applying steam direct to the wheels of the passenger car is a very difficult one and has never been attempted on a large scale. A separate locomotive must be used, and this locomotive must have sufficient weight upon its drivers to give the necessary adhesion to enable it to exert the required tractive force upon the train which it is pulling. The safe weight on each wheel being limited, the total maximum weight on the drivers is determined by the number of wheels to which the steam power can be applied without too much complication and rigidity of truck. The power of the locomotive is also limited by the size of boiler which can be mounted on its wheels, by the amount of water and coal that can be carried and by the capacity of the fireman to feed the furnace. Boiler, tender, fuel and water, while necessary for the operation of a steam locomotive and utilized in part for giving the required adhesion of the driving-wheels, are, in one sense, so much dead weight to be carried. All these difficulties and objections can be avoided if motors can be used requiring neither fuel nor water, applied direct to the axles of the car, and utilizing for traction the weight of the car and its paying load.

The electric motor, supplied from a wire with current generated in a distant power-station, exactly meets these requirements. It is not a difficult problem to mount a 200 horse-power motor on each of the six axles of two six-wheel trucks, carrying a car of large dimensions accommodating a hundred passengers or more, the load being distributed equally on the twelve wheels with every pound of motors, car and passengers utilized for traction, enabling this 1200 horse-power locomotive, which is a passenger car in itself, to haul as heavy a train of additional cars as could be pulled by a steam locomotive of the same weight and power. It has even been suggested that motors might be attached to each truck of every car in the train. While this would be possible, it would involve undesirable complication in the connections between the cars, and more especially in the device for controlling the motors. The tendency in electric railroading will probably be towards more frequent and shorter trains, consisting of either a passenger-car-locomotive hauling one or two cars, or preferably of a single car ot mammoth dimensions, equipped with its own motive power and avoiding all the objections of long loosely connected trains. For such service electricity is peculiarly adapted and is, in fact, the only known power suitable for the purpose.

It is needless to dwell in detail on the increased comfort of passengers given by a car of this description, with its freedom from smoke and cinders, perfect ventilation and unrestricted view. Anything which increases the comfort and luxury of travel will command a higher price, and higher price will help pay dividends on the greater investment required for electric equipment. It should not be concluded that the introduction of electricity will necessarily be accompanied by increased cost of travel. The tendency is toward a reduction of railway rates, and there is no doubt that travel, whether by steam or electricity, will be cheaper twenty years hence than now. But at any given time and under the same general conditions, the more perfect and comfortable service will command the higher price.

Watt is said to have remarked "I have what every subject of your Majesty wants,—power." Another thing which the people and especially the American people want is speed. Given a guarantee of safety, it is difficult to place a limit on the speed of travel desired by the busy man of the present age. Great expectations are generally entertained as to what electricity will do in this direction, and while there is no reason to expect a sudden leap to the marvelous speeds sometimes predicted, there are good reasons for the faith that electric power will render practicable speeds impossible with steam. The speed of a steam locomotive is limited by many causes, which either do not exist at all or exist to a much less extent with electric power.

One of the limitations in the steam locomotive is the allowable speed of the numerous moving parts, especially the piston and valves. By the use of larger drivers more ground can be covered with the same piston speed, but the steam pressure must be increased, and here again a limit is reached.

The pounding produced by the reciprocating movements of the many parts, which is injurious to machinery and track and doubtless enhances the danger of derailment, increases with the rapidity of these movements. In this connection must be considered the difficulty of accurately counter-balancing such parts as the driving wheels, the slightest error in which causes a hammering at high speed which is extremely objectionable.

Train resistance (especially air-resistance and "concussion") increases rapidly with the speed. The power required, which is measured by the product of resistance and speed, rises still more rapidly, necessitating larger locomotive, greater boiler capacity, and grate surface, more coal, water and labor, and increased weight on the drivers to give the necessary traction. In all these directions a limit is soon reached.

The electric motor has but one moving part, the armature, and there is no difficulty in giving this a speed sufficient for any rate of travel yet contemplated. An armature being absolutely symmetrical can be perfectly balanced and its rotary motion has none of the objectionable effects of fast reciprocating motion, and doubtless involves less danger of derailment.

For the reasons previously discussed, the increased resistance due to high speed is a less formidable obstacle with electricity than with steam. This resistance can be greatly lessened by the use of a single large car containing its own motive power (rendered possible by electricity), which can be so shaped as to reduce air resistance to a minimum, and which, by the avoidance of numerous cars coupled together into a loosely jointed train, will greatly decrease "concussion"; there is no serious difficulty in equipping such a car with all the power required; the entire weight being on the drivers, there is no trouble in regard to traction; the boiler, fuel, water and firemen are in the distant station where there is plenty of room for them and no limitation to their capacity, amount and number, excepting that of expense.

After all, whatever the method of propulsion, expense is the principal consideration. The question is not "What speed would the people like?" but "How much speed are they willing to pay for?" Electricity, by decreasing the engineering difficulties which now make high speed impracticable, or obtainable only at enormous expense, will certainly pull up the stake heretofore supposed to mark the approximate boundary in this direction, and set it considerably farther on.

The advantages of electricity which partly or wholly compensate for its greater cost may be summarized as follows:

Higher efficiency or economy of steam plant; saving in repairs; utilization of weight of car and passengers for adhesion; greater comfort of passengers; increased speed.

The question of relative *economy* of the two powers depends so much on circumstances and is so uncertain in the present lack of experience with electricity in this service, that it is scarcely possible to make a reliable comparison. The subject has been sufficiently investigated, however, to show that where the conditions are suitable, electricity will compare favorably with steam on the basis of cost of operation. Where this proves true, its probable gain in speed and indisputable advantages in comfort will certainly turn the scale in its favor.

Because electric power possesses so many attractive and advantageous features for railway work, it by no means follows that it is suitable for all roads. Like steam, it has its limitations, although in a different direction, and the conditions must be favorable to permit its satisfactory and economical use.

The chief limitation is that of distance. Long distance transmission is rendered possible by the law that if the voltage is increased in proportion to the distance, the cost of copper remains the same. The beauty of this compensation is marred, however, by the fact that, whatever the system employed, there is a limit to the voltage which can be satisfactorily controlled in apparatus and line. In the direct current system, this limit for railway service is not far above 1000 volts, and at this voltage the power stations would have to be located at such short intervals as to bar it from consideration for long distance railways. The multi-phase alternating system, which is so rapidly becoming the cynosure of all electricians, permits the use of low-voltage currents in generators and motors and (by means of transformers) very high-voltage currents on the line. While there are some technical difficulties in the application of this system to railroad work, there is no reason to think that they are insuperable or to doubt that it will greatly extend the distance over which roads can be satisfactorily and economically operated by electricity.

The storage battery is another "young hopeful" of which the public entertains great expectations. Its growth has been somewhat slow and disappointing, but this is partly due to the atmosphere of legal uncertainty by which it has been surrounded, and there is good reason to believe that before many years the storage battery will be a practical success for many kinds of work. For street car service its advantages over the trolley system, *provided it can be made equally practical and economical*, are generally recognized. For long distance railways it has several attractive features as compared with the trolley system. It would avoid the difficulties and complications of enormously high voltage and the technical difficulties previously referred to in the application of the multi-phase system to railway work. It would enable electric trains to be run on any existing track without the construction of line work. It would save the cost of "step-up" transformers at each station, primary line work, "step-down" transformers (which must be placed at intervals of a few miles, and each set of which must have capacity to supply the train while on that section), and secondary line work from the step-down transformers, all of which, on account of the long distances between stations and large power transmitted, will be very expensive. It would enable the generating capacity of each station to be reduced to just enough, when worked continuously, to charge the batteries during the intervals between trains, while with the trolley system, each station must be large enough to operate the train or trains that may be on its section at any one time, although idle during the remainder of the day.

The natural conclusion from this comparison is that the trolley system will find its most favorable application on roads with heavy traffic where the stations can be placed at moderate intervals and given steady work, while for lines with less frequent trains, the storage battery offers the most hopeful and in fact the only economical solution.

When the storage battery can be made at half the present price, with twice its present life and capacity per pound of battery, and with a safe and fairly efficient discharge rate twice as high as the present limit, conditions by no means hopeless, it will become a very formidable rival of the trolley.

As the electric road is only six years old and scarcely anything has been done as yet towards the operation of long distance railways by electricity, it may be considered a little early to venture any well defined predictions on the subject. The indications are, however, that within five years electricity will be the generally accepted power for elevated and underground roads as well as for surface street car service ; that in ten years numerous inter-urban roads from ten to thirty miles in length will be electrically equipped ; that in twenty years some of the large railway systems enjoying the heaviest traffic will consider electric passenger service essential to their welfare ; that, both for the convenience of the public and economy of operation, the tendency will be towards more frequent and smaller trains ; that a maximum speed of 150 miles, and a schedule rate of 75 miles per hour will not be considered remarkable ; and that within the life of the present generation we will see the present long train of loosely coupled cars with their restricted space, poor ventilation and light, imperfect facilities for viewing the scenery, and annoyances from smoke and cinders, give way to a single car of liberal dimensions, shaped on scientific lines to cleave the air at high speeds with minimum resistance, equipped with noiseless electric motors, free from the disagreeable products of the steam-locomotive furnace, designed to afford the passengers an unrestricted view in all directions, perfectly ventilated, lighted by electricity, and capable of a speed that will cover the distance from New York to Chicago between sunset and business hours next morning.

EDITORIAL

A Notable Departure.

THOSE of our readers who have followed HE ENGINEERING MAGAZINE since its arly numbers, are in a position to share he gratification and just pride which we eel over the inauguration of the comianding feature which appears elsewhere nder the caption “ Review of the Indusial Press.” The idea suggested by this tle is not new to these pages, nor is the ystem of reviewing important publications n the least new to modern journalism. ut in both method and matter this dearture represents the final and full realiation of an ideal toward which we have een moving from the beginning, and as uch it may be confidently heralded as one f the most important departures yet taken n technical journalism.

In the first number of the Magazine, ow nearly four years ago, there appeared modest little department entitled “ Our xchange Table.” It consisted of but two ages of large type, and was designed ierely to suggest that we intended to ive each month a list of notable and valable articles appearing currently in our xchanges. In the succeeding numbers this epartment grew to three, four, five, and ix pages in length, and by the end of the rst half year it had taken on an engraved eading, entitled, “ Editor's Exchange Tale—An Index to Current Technical Litrature.” By this time, too, it was recogized on every hand as one of the most nportant features of the Magazine, and hough abridged in size and imperfect in lassification, it yet represented a wellelected list of articles every one of which as valuable. Meanwhile the various edorial departments supplied a great numer of excellent reviews of noteworthy pubcations in every field of applied science, nd we were often felicitated over the fact iat these reviews, in conjunction with the ndex, enabled the busiest of men to keep in close touch with practically everything of value in current technical literature.

But the end of the first year brought a crisis. The idea of supplying copies of the articles catalogued had been added to the scheme; the Index had grown to full sixteen pages of small type; and there was such constant demand for further enlargement, in both size and scope, that its publication as part of the Magazine seemed to be no longer practicable. It was accordingly decided to issue “ The Technical Index” as a separate publication, and, by way of reparation for its withdrawal from the Magazine, to commit each of the editorial departments to the personal conduct of a distinguished expert—thereby imparting the added interest and weight of personal and professional responsibility to every utterance in our pages. In accordance with this plan the first number of “ The Technical Index,” as a distinct publication, appeared in April, 1892, and the issue of the Magazine for the following May appeared without it.

The change, however, gave immediate and unmistakable evidence of being a blunder. A fusillade of protests set in from every quarter, and the prevailing opinion was happily crystalized by one critic of high standing in the engineering world, who said: “ You *may* make the Index a success, but you have robbed the Magazine of precisely that feature which I have always felt would ultimately make it the greatest of our engineering journals. To me it seems like removing a man's spinal column and then training him for an athlete.” In the light of experience there was no answer to this argument. The Index was immediately restored to the Magazine, where it has remained ever since as its most commanding single feature—giving almost hourly evidence of appreciation by subscribers in every quarter of the globe.

But this restoration served only to renew and augment the demand for extension and enlargement. Every day was apt to bring its suggestion, and every suggestion served to emphasize the need for a scheme of presentation which, in addition to being definite, comprehensive and systematic, would also *give more information* concerning important publications, and give that information in concise, readable form. To recount all the suggestions to this end that have been considered during the past four years would be impracticable here. Suffice it to say that under suggestion, discussion, revision, and extension—a process of natural evolution—the original department of two pages has expanded into eighty odd pages with this number, and aside from being the most extensive review of technical literature ever before presented to the industrial public, we believe that the method of presentation is the most perfect yet devised by any one.

As indicated by the introduction to the Department, the aim is to give expert reviews of the *most important* publications of the month, in every field of applied science; to supply a complete index to *all* the leading articles published in the scientific and industrial journals of all the English-speaking peoples; and finally, through the Clipping Bureau, to furnish the original and full text of each and every publication so reviewed or catalogued. That is to say, as a review it does for industrial literature precisely what the *Review of Reviews* does so admirably for the political and literary world; as an index it is to the technical expert just what Poole's index to periodical literature has long been to the literary worker; and it is a long step in advance of these two celebrated publications, in that it affords an easy and inexpensive means of procuring all or any portion of the literature under review. For these reasons we commend it to our readers, unreservedly, as the most helpful aid that newspaper enterprise has yet placed at the service of busy workers in every department of technical and applied science; and we look upon its inauguration as the crowning epoch in the career of this Magazine—a career which we believe is without a parallel in the annals of technical journalism in point of its immediate, substantial, and enduring success.

Industrial Discontent.

THROUGHOUT the civilized world the laboring classes are manifesting a painful discontent with prevailing industrial and commercial conditions. The intensification of this unrest seems to many profound observers of events a menace to the social structure. In no country, except perhaps Russia, has this feeling been more pronounced than in the United States. But in Russia, kept down by a powerful military force and rigorous police control, it has not been able to assume openly the threatening aspect it has lately presented in the United States.

With some it is held that what has been called our "marvelous progress" has been a forced march toward a complete overturn of the institutions founded by patriots who achieved American independence, and who, as they truly believed, framed the most liberal form of government that has yet blessed the human race. Those patriots and statesmen, however, foresaw many political and social dangers to be shunned, and in their speeches and writings set up beacons of warning. They were not sure that what appeared so fair at its dawn would be a political day without either clouds or storms. But, though they viewed the future with anxiety, they hoped and trusted.

While the government was yet young,—while America was ruled by Americans in feeling as well as in name—it seemed indeed a paradise as compared with older states. Extremes of either wealth or poverty were rare. Villages were centers of prosperous industry, and every one who wanted work could find it. Class distinctions hardly existed. The lawyer, congressman, physician, merchant, clergyman, teacher, mechanic, farmer, and the man who could live on his income, came together on one social plane, sharing a truly democratic spirit. Our legislative halls were then filled by representatives above the suspicion of corruption. The period of rings, lobbies, and combinations of money power to influence legislation had not arrived. The vast public domain had not been given away to foreigners or placed on sale for the benefit of greedy speculators. 'Uncle Sam was rich enough to give us all a farm." Politics had not yet become a business to be pursued for amassing wealth.

The change which has been wrought during half a century has been in itself almost a political revolution. If men like Webster, Clay, Jackson, Jefferson, Franklin or Washington now exist, they are not politically known; because men like these, who cannot be controlled by some commercial interest or some political ring, are not wanted in office by those who can control nominations. A very large proportion of the population is a foreign element whose customs and education are not adapted to assimilation with the spirit of American institutions, as the latter existed in the first half of this century.

The best part of the public domain has been bestowed, not upon American citizens, but upon the needy of other lands, or has been purchased by home and foreign capitalists purely for speculative purposes. The trades that once supported in comfort multitudes of independent mechanics, in business for themselves, have practically disappeared. The goods and wares which these once produced are now supplied by enormous manufacturing esablishments through the aid of machinery. Instead of being thrifty, independent workers on their own account, nechanics are now, with few exceptions, educed to the condition of wage earners, heir small incomes dependent often upon he state of commerce or the will of the naster who gives them leave to toil. The gricultural part of the population find heir burdens steadily increasing. Reail merchants with small capital are gradually being crowded out of business by huge bazaars that are rapidly absorbing etail trade; and the merchants thus driven rom trade are fain to become wage earnrs in the larger establishments.

This, then, is the condition of affairs which confronts the industries of the United States. While the number of employers is diminishing the number of those who must live, if they live honestly, upon their wages as employés, constantly increases. It is this tendency, together with the shameful robberies of the people and defeat of popular will effected by political organizations, that, more than accumulation of wealth in the hands of a few, is putting an alarming strain on our social structure.

The wage system was a great step in civilization beyond serfdom; but it does not wholly liberate men from dependence upon the will of others. The masses of men, reduced to the condition of wage earners, will not rest content without some security against total loss of employment or the reduction of earnings to the point of bare subsistence.

Machine work has replaced manual labor till the latter finds itself subordinate. This is a new condition that has come upon the human race suddenly, and has found the world unprepared to meet it. It is certainly not compatible with true civilization that great numbers of men, women, and children find themselves on the down grade toward increased dependence upon public charity. Remedies must be found.

But the industrial revolution wrought by invention must be accepted. We cannot discard machinery and go back to manual labor for the supply of either old or new wants. We must take social materials as we find them, and out of present conditions strive for a happier state.

The improvidence with which we have squandered the public domain, unexampled in history, handicaps us at the start. The equal imprudence with which we have been admitting immigrants to the political family without regard to qualifications for citizenship, and granting rights of citizenship to all so admitted after a merely nominal sojourn here, with all the evils this system has entailed, handicaps us still further. The social problems presented are by no means easy of solution. Those who shall grapple with them need to be men of the largest mental caliber, soundest principles, and broadest sympathies. It is a hopeful sign of the times that both foreign and American journals, hitherto confining themselves to purely technical subjects, are beginning to open their columns to discussions of social aspects of industrial progress. Henceforth, until industry emerges from its present troubles, such discussions will take first rank in popular interest.

An Abuse of the Patent Law.

WITHIN the past fifteen years, there has grown up in this country a systematic and pernicious practice of patenting a certain class of so-called inventions which are in fact nothing more than obvious mechanical or engineering expedients, and which involve in their production nothing whatever beyond the ordinary intelligence and skill which every experienced craftsman must almost of necessity possess. The electrical industries especially have suffered greatly from the numerous attempts to appropriate as many as possible of the fundamental engineering expedients and methods essential to the economical production and distribution of electrical energy on a large scale. It has long been predicted that if ever one of this class of patents should come to be passed upon by an intelligent and clear-headed judge, who had sense enough to perceive that the mere application of a well-known principle to the control or distribution of electricity instead of steam, gas, or water, did not necessarily call for the exercise of inventive skill, this practice would be likely to receive a severe check. The occasion has at length arisen, and fortunately for the industries of the United States, the man for the occasion was on hand. In distributing gas to consumers by means of mains laid along the streets, it has been known for half-a-century past that when the number of consumers on a particular main had become so great as to cause inconvenient fluctuations in pressure at times of maximum and minimum consumption, the obvious remedy was to lay an additional pipe connecting the region of minimum pressure with the source of supply, and to so proportion the entire pipe system that the fluctuations of pressure would take place in this supply pipe and not in the consumer's mains. The same thing was equally well-known in respect to systems of water-distribution. When it came to the question of distributing electricity on a large scale, precisely the same problem once more presented itself, and inasmuch as the mathematical formulæ for computing the capacity of conductors and the fall of pressure in the case of electricity are identical with those applicable to fluids generally, and had been known to be so for generations, nothing remained but for the engineer to apply these same old formulæ, and thereby determine the arrangement and relative capacity of his electric conductors. Nevertheless a patent was taken out in the name of a well-known inventor, purporting to cover any such organization of conductors for distributing electricity in which the capacity of the supply conductors or feeders is less than that of the mains! It is not a little surprising that the Patent Office should ever have granted such a claim, and it is still more surprising that a circuit court should ever have been found to sustain it; but as the French say, "It is the impossible that happens," and so it was in this case. Now, after years of tedious, annoying, and costly litigation, Judge Acheson, of the Circuit Court of Appeals, in a most able and luminous decision, has swept away at a blow the entire accumulation of sophistry and special pleading with which it has been attempted, not without a considerable measure of success, to bolster up this most objectionable and indefensible class of patents. In his opinion, reversing the decree of the lower court, Judge Acheson says: "In truth, the feeder and main system of distribution came naturally, in the ordinary course of incandescent lighting, as and when needed. . . . The proper proportioning of the two parts of the combined circuit involved only the exercise of the common knowledge and skill of the electrician. . . . The plan of electrical distribution covered by the claims in question is not 'the creative work of that inventive faculty which it was the purpose of the Constitution and patent-laws to encourage and reward.' To sustain these claims would be to sanction a monopoly in that which belongs to the public."

The importance of this righteous decision lies not so much in its application to the particular patent under consideration, although the importance of this is by no means to be underrated, as to a great number of even more indefensible claims of the same general character, which have succeeded in passing the scrutiny of the Patent Office, and under color of which the public would in due time have been called upon to pay most onerous tribute in the guise of reward to worthy inventors. Henceforth systems for the distribution of electricity, like systems for the distribution of other fluids essential to the comfort and convenience of man, will in all probability have to be exploited on their own merits, without the assistance of a patent monopoly. F. L. P.

Architectural Ideals.

AN exalted architectural ideal is a noble thing. It stimulates its creator and ennobles the men who may have the privilege of enjoying it in its completed form. The noblest buildings of the world are the visible material expression of architectural ideals. They are great thoughts expressed in stone or brick or other building substances. Given form that is practically imperishable—more lasting, indeed, than that of any other art—they have stood, many of them, as proud records of some of the finest conceptions of mankind. Men of all subsequent ages have bowed down in admiration before them, found inspiration, happiness, faith, joy, satisfaction in them; been better for their influences; been spurred to greater effort that they might themselves profit by the splendor of the thought displayed in these superb monuments. The rhetorician, astonished and overcome by their grandeur, may lapse into error in singing their praises perhaps, but his interest may not be harmful. Upon the architect the effect of such work is incalculable. Who would not exchange his most valuable possession—life itself, perhaps more than that—if he had made the Parthenon, the cathedral of Paris, the dome of St. Peter's?

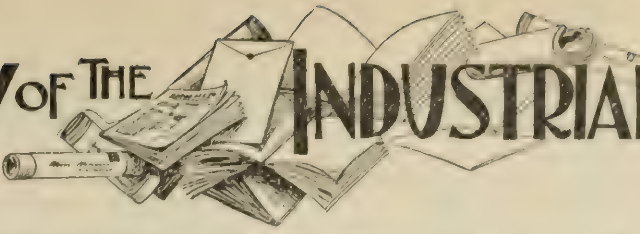
We do not know that we should like to follow the full extent of the architectural mental operations of previous times. The great temple at Karnak grew year by year, was added to by Pharaoh after Pharaoh, but we cannot say just what conception the man had who began it, nor on what scheme the final great series of buildings was carried out. But whether this building was conceived, on general lines, as an entirety at once or not, the final effect was single and united. The group of buildings—for it is a misnomer to speak of them as a single structure—illustrated a great idea in a great manner. The medieval cathedral, though its growth extended often through centuries, grew along certain general lines determined at the outset. The cathedral of Paris was not begun until the idea was thoroughly mastered at the beginning. This once determined upon, minor variations were of small moment. The ornament could be changed at will; the fundamental lines of the building must be fixed and definite to permit the idea to be carried out. So the beginners of these buildings, and all others of their class, started out with an architectural ideal, which they felt to be so great, whose truth was so real to them, whose beauty so marked, that they had amplest confidence that the structure would be completed on very much the lines they laid down—that the lesson they sought to teach would be taught.

The modern architect, with all the world's noblest conception in architecture before him, may well aspire to the creation of architectural ideals that will place him in the same category with the world-acknowledged masters of their art. And an architectural ideal being a noble thing, it is not less noble in the breast of the modern architect than in the heart of the greatest builder of the past. It is as good and noble now as it ever was. But is it wise? Is it profitable? Is it useful? Architectural ideals are too great things to be hastily destroyed. The world is much too sordid. This sordid world can ill spare a noble thought of any sort, and a noble architectural thought least of all. But the conditions of modern architecture are not conducive to the creations of architectural ideals as they were in the past. Civilization that has brought so many advantages (and curses) to humanity has so changed life and men that what were once ideals in architecture are so no longer. The Parthenon represents an architectural ideal both for our own age and for that in which it was built; but a modern Parthenon, and an actual copy most of all, would be a simple curiosity, without the smallest living interest. This day and generation is concerned with other things and other buildings; and things and buildings of so new a type, of so strange a meaning, and of so novel a purpose that the old architectural ideals need to be transplanted into a totally new language, transformed into other forms, used in other ways, before we can have an architectural ideal that is at once illustrative and emblematic of our own time. This may not always be pleasant work. It is easier to create new ideals on old models than to wholly transform and rejuvenate them. Nor is this all, for this is a most unidealistic age. Though culture and civilization have had their most splendid flower in this age, the age is not kind to ideals. The architect who sets up lofty standards before him is likely, sooner or later, to find that he has been depending upon a broken reed. The modern atmosphere badly agrees with ideals, and the sooner architects admit this fact, the sooner they cast off traditionary ideals and take up the study of the modern, the better it will be for their art and themselves. Young men, starting out in life with a large stock of ideals, need not be too careful of them. Sooner or later they will all be broken. Unless their actual relationship to modern life is discovered in the process the result is likely to be painful. An unidealized architect, with nothing to fill the place of his lost hopes and aspirations, is a heart-rending spectacle. B. F.

New Trade Catalogues.

In this age of rapid advancement in the technical arts, coupled with the possibilities of large financial rewards for individuals who may happen to make valuable discoveries or who may be placed in charge of important constructions, it is only natural that the leaders in the material progress of the world should not be writers of books recounting their work. At best technical books have but a limited sale, with small returns in money for their authors. At the same time, the promoters of valuable inventions or devices, in order to attract buyers, have gone to great expense in preparing descriptive catalogues, until many publications of this class possess a real value as a record of the latest progress in their respective branches of art. Indeed, no mechanical or industrial library to-day can be complete without a file of catalogues of the leading manufacturers of machinery, tools, and appliances, in many of which are embraced important facts not yet embodied in any volumes in the booksellers' trade. One important reason for the non-appearance of books in certain arts is the probability that even while a work is going through the press discoveries may result to render some part of it obsolete. An illustration of this tendency is shown in the case of a company organized recently to manufacture a certain new bicycle tire, which it was found advisable to discard on account of another invention made while advertising matter for the first tire was being prepared. Since trade catalogues can be produced with more facility than books having real value, the former can be the more easily kept up with the times, and thus be made to record more promptly the improvements constantly in progress. These considerations apply to trade catalogues with respect to their usefulness in the technical library, in addition to the primary value of the carefully-prepared catalogue as a guide to buyers in the trade which it is intended to reach. Thus there is a double reason for incorporating in our department of "New Books of the Month" a record of the catalogues produced from time to time by the leading firms in the lines of manufacture allied to the scope of the Magazine. It may be stated, in general, that the catalogues here noted are intended for free distribution to those who may be entitled to them.

REVIEW OF THE INDUSTRIAL PRESS



WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THE purpose of this Department is, (1) to give concisely written, expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published monthly in the scientific and industrial press of the United States and Great Britain, and (3) to afford, through our Clipping Bureau, a means whereby the full text of any one or more of these articles may be immediately procured at the minimum of cost and trouble.

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles, addresses, and initials of all the journals regularly reviewed are given alphabetically below, but in the body of the Index only the initials are given. Other abbreviations used are, Ill=Illustrated; W=Words.

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C R......Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
E.........Engineering. *w.* 36*s.* London.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E G......Engineers' Gazette. *m.* 8*s.* London.
E L.......Electricity. *w.* 7*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
EngL... Engineer. *w.* 36*s.* London.
E P......Electrical Plant. *m.* 6*s.* London.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* London.
F R......Fortnightly Review. *m.* $4.50. London.
F'y......Fairplay. *w.* 32*s.* 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G M.....The Geol. Mag. *m.* 18*s.* London.
G W......Gas World. *w.* 13*s.* London.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s.* Lond
I C B.....Carpenter and Builder. *w.* 8*s.* 8*d.* London.
I C T......Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I E.......Indian Engineering. *w.* 18 Rs. Calcutta.
Irm......The Ironmonger. *w.* 10*s.* London.
Inv......Invention. *w.* 11*s.* London.
J G L....Journal of Gas Lighting. *w.* London.
J S A....Journal of the So. of Arts. *w.* London.
M.........Machinery. *m.* 9*s.* London.
M E......Marine Engineer. *m.* 7*s.* 6*d.* London.
Min W..The Mining World. *w.* 21*s.* London.
M J......The Mining Jour. *w.* £1. 8*s.* London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N....... Nature. *w.* $7. London.
N C......Nineteenth Century. *m.* $4.50 London.
P Eng...Practical Engineer. *w.* 10*s.* London.
Pl D .....Plumber and Decor. *m.* 6*s.* 6*d.* London.
R P L....The Railway Press. *m.* 7*s.* London.
R W.....Railway World. *m.* 5*s.* London.
Ry T.. ..The Railway Times. £1. 5*s.* London.
S L......Steamship. *m* Leith, Scotland.
S R......Sanitary Record. *m.* 10*s.* London.
Tr.......Transport. *w.* £1. 5*s.* London.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

The Abbot's Barn, Glastonbury, England.

THAT which is old has special charms for most men; simply on account of its antiquity, and if at the same time it has the added charm of artistic beauty or of historical interest, or both, such a graphic word-picture of it as Mr. A. B. Bibb has drawn of the great Tithe-Barn of Glastonbury Abbey, in the *British Architect*, is delightful reading. This old building dates back to a time prior to the reign of Henry VIII; and it belonged to one of the "earliest Christian establishments in all England,"—one whose name "looms out of the mists that enfold the legendary days of Briton and Saxon."

The title might lead one astray as to the scope of the paper, which includes a brief history of the rise and fall of this great establishment, from a primitive church of wattles and timber built by the Britons, to a monastery church founded by King Ina, a church of stone erected in the eighth century by Dunstan, most renowned of all the abbots; the gradual growth of the abbey to the height of influence, wealth and power; the seizure and confiscation of such of its property as the monks could not hide, and the cruel butchery of Richard Whiting, the last of a hundred abbots of Glastonbury, because he stubbornly refused to reveal where the concealed treasure had been placed. These materials, and scraps of interesting and amusing legends are worked up most entertainingly in an introduction to a description of what are probably the most interesting remains of ancient ecclesiastical architecture in England.

Of these ruins, the old Tithe-Barn, now used as a dairy, is the most conspicuous and best preserved. "It seems a great pity that this remarkable old structure should not have fallen into hands which will lovingly and reverently preserve it as a rare architectural monument of great beauty and interest. It is yet in a surprisingly good state of preservation, and, such is the solidity of its construction, will probably survive many centuries more if cared for. As it is, many slight dilapidations and changes are occurring, and the old barn is suffering irremediable damage."

The general description of the architecture of the Abbey church, St. Joseph's Chapel, the so-called "Abbot's Kitchen" and other buildings belonging to the establishment in its palmy days, forms instructive, as well as entertaining reading. These buildings were examples not only of noble art in their design, but also of a type of buildings erected to endure through many centuries.

The roof construction of the old barn is a singularly interesting study. The author declares it "more elaborate and ornate than many churches afford." It is a remarkable example of the massive, braced and framed carpentry of Gothic England, "put together without nail, the dairy folk proudly inform visitors, sound in every timber and good for a long time to come."

Altogether, considered with reference to its literary excellence, more than its technical value, this is one of the best papers that has recently appeared in architectural publications. It will be read with pleasure and profit, by both professional architects and laymen.

The Ancient University of Paris and Its Colleges.

A GREAT disappointment usually felt by English travelers visiting university towns on the European continent, caused by the want of resemblance in the architectural features of such towns to the famous old university towns of England, is made the opening text of an extremely interesting leading article in *The Builder* under the title given. It is asserted that an Englishman visiting the continental universities "looks in vain for any counterpart of Oxford or Cambridge with their magnificent groups and assemblages of academic buildings. It is true that here and there he may find some single structure that recalls an Oxford or Cambridge college." Certain exceptional buildings possessing such resemblance are cited; but it is asserted that they are solitary examples, and that, "to an Englishman's mind one college can no more convey the notion of a university than one swallow can make a summer."

"He thinks of Christchurch, Merton, Magdalen, and some twenty others, or of Trinity, St. John's, and all their companions, forming grand architectural groups crowned by spires, domes and towers. He pictures to himself streets flanked by wide-fronted buildings; and gateways leading into noble courtyards, with lofty buttressed and pinnacled chapels; dining-halls with pitched roofs and louvres, and exquisite gardens and groves running down to the banks of a clear river."

The various universities of European towns are then passed in review. Paris comes in for a severe criticism upon the decay of architectural beauty in her university buildings.

"The want of grandeur and dignity in these buildings of Paris is all the more strongly accentuated from the fact that all the old buildings in the neighborhood are characteristic, and many of them extremely beautiful. The splendid old church of St. Étienne du Mont, the stately Romanesque St. German des Prés, the interesting Gothic churches of St. Severin and St. Médard, the lovely Flamboyant Hôtel de Cluny, the stately Renaissance St. Sulpice, the Luxembourg, and notwithstanding a certain amount of ugliness, even Soufflot's portly bulk of the Pantheon are all striking examples, and possess those merits which are remarkable by their absence in the university buildings. How the latter must have deteriorated from what they were in mediæval times; and how a single century has sufficed to convert what was once an Oxford or a Cambridge into a dull, gloomy 'education factory.' It is next to impossible to realize the fact that, on this same spot, formerly stood a series of academical buildings which were unsurpassed anywhere in Europe."

An interesting list and brief descriptions of these old buildings follows, and the author finds it difficult to account "for the constant destruction of ancient monuments which is going on all over France, and more especially in Paris." Some will see in this a decay of taste perhaps traceable to a change in the character of the French people since the republic has supplanted monarchy; but however this may be, the fact remains that reverence for the past is not evinced by conservation of architectural features whose beauty and grandeur ought to be carefully preserved as the inheritance of future generations.

The Origin of Gothic Architecture.

A RATHER transcendental view of this subject is taken in an article written by Mr. C. Bryant Shaefer in *The Inland Architect.* He classifies architecture into three principal orders, to wit, "Mohammedan, the feminine; Grecian, the masculine; and Gothic the expression of both. The Roman, Romanesque, Byzantine, and many other styles are variations on the principal themes." The aim of the article appears to be to sustain the thesis that Gothic architecture was the natural expression of the new growth in "higher experiences which the world entered upon nineteen centuries ago." Good samples of the flavor of this article are presented in the following propositions:

"The first digramatic illustrations made by man proceed at once upon diametrical lines of development. One of these is literal representation and the other illiteral. The former is the systematic progress that develops into alphabets. The latter is the cultivation and the expression of faith. It is ornamental as opposed to the useful.

"Gothic art and all art, it must be remembered, is the opposite of religion, as commonly understood. The modern symphonic-drama is its culmination, and bears the same relation to this new sphere of exercise as the Pantheon, created by the Greeks, did to their accomplishment. The old philosophical process, best represented then by Socrates, accompanies it as the natural mental condition of the present."

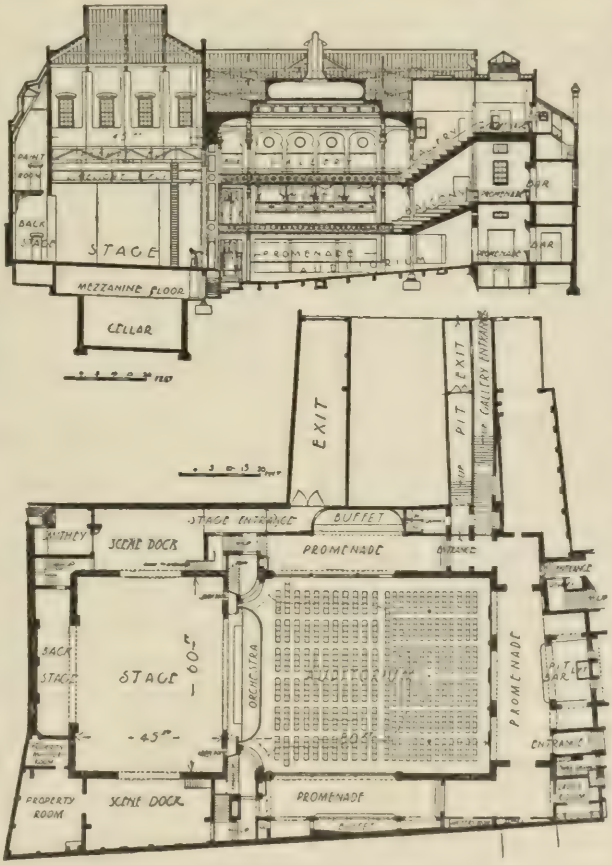
There is an esoteric flavor to this discussion that a certain class of readers will relish.

Theaters—V. The Paragon Theater.

AN important series of papers on this subject from the pen of Mr. E. A. E. Woodrow, is continued in this, the fifth number of the series in *The American*

Architect, wherein is given an illustrated description of the Paragon Theater, situated in the Mile End Road, Whitechapel, London. The characteristic feature of the paper is that it describes minutely a place of amusement designed to meet the requirements for the poorer classes of population in a very large city; and from it may be obtained hints of value to any architect who is liable to be commissioned with the execution of similar work.

The theater had its origin in an East End music hall, which has been transformed by the architect's skill into a building completely adapted to its present use and the character of its patrons who, the author states, are in many respects unlike any other part of the population of London. "The character, dress and even accent of the East Enders are characteristic and unique; the coster and his girl have been the subject of so many sketches and illustrations that, doubtless, their peculiarities are familiar even to the readers of this professional journal."



LONGITUDINAL SECTION AND PLAN OF PARAGON THEATER, LONDON.

To accommodate the requirements of this peculiar class of patrons "a large and open floor for occupants of the area, or pit and stalls seats" has been supplied, and these divisions of the audience are surrounded "by raised promenades on three sides, the fourth side being occupied by a stage of such a size as to be capable of mounting any play or ballet." This arrangement is said to have proved singularly well adapted to the wants of those who patronize the theater. Other very interesting details related to the special requirements of this case, are given; and as a study of adaptation to such requirements this number of the series appears to fully warrant the view that the theater described is an example of rare value in this particular field of architectural design. A plan and vertical section of this theater are given in the accompanying diagrams.

How to Study Design.

In a paper recently read before the Architectural Association, London, by Mr. A. Berbsford Pite, discussing the study of architectural design with reference to the future of architecture, is made an exceedingly strong plea for originality finding its spring and impetus in the wants, characteristic features, and tendencies of the present age, rather than in the spirit of past ages. It is much easier, as a rule, to ask than to answer questions beginning with the small but immensely embracing interrogative, "Why?" So when the author, at the very outset, hurls at us a number of ponderous queries such as are quoted below, and then proceeds to answer them, something quite original and interesting may be expected in the replies. In this expectation the reader will in no wise be disappointed. Among many questions propounded and discussed with ability are the following:

> "Is it possible to design in harmony with the spirit we live in, or to distinguish between the archæological and architectural beauty of ancient buildings? Why cannot we design buildings as an engineer designs an unsophisticated iron bridge without the result being hideously ugly?

"Will not the terrible buildings of the Victorian Gothic Era with which our land is bespattered have in the eyes of succeeding generations the same beauty (is it architectural or archæological) that the crude classic productions of the Jacobean and Queen Anne periods have in our own?"

This last question is freighted with an idea that pervades the entire discussion, to wit, that much of the beauty attributed to ancient architecture is archæological rather than architectural, and that fondness for what is old cannot rightly be made a standard for beauty or fitness in the present stage of human progress.

"Imagine yourself, if you can, sitting down to design a church or a house in the country with the stipulation that you were not to revive any ancient style in your building. Does not the thought seem both absurd and painful? If so take for your subjects either a factory, say for boot blacking or fancy soap, or a railway station block, in which it ought to be both absurd and painful to employ any ancient style, and see how you will be able to get along without the seemingly indispensable history. And yet, if history teaches us anything as to the sources of life and motive in design, it shows that the Greeks had little or no history of architecture to draw upon and revive; and that the Goths, who probably knew little or nothing as to ancient art, deliberately set aside the productions of their ancestors, even as types, and thought and acted for themselves alone. Can any one say the results do not justify their methods of study? Shall we be forced to accept as a conclusion that the less we have of the study of architectural history, as at present conducted, the better?"

The author disputes the propositions that "ancient styles are the languages of the art of architecture, that their forms and details are its words, and that our fine imaginings without such words and diction are vain and incapable of realization"; and he asserts with equal positiveness that, while it has its uses, the study of ancient styles, and of other things the mastery of which will qualify a student to pass the art section of a qualifying examination, is "in no sense a qualification for the practice of modern architectural design."

In the view of the author a reconsideration of methods that will bring the profession of architecture face to face with present problems, rather than the championship of a "past style and dead art,"—a method that will supply equipment for advancing the art in the spirit of the age, is what is needed at the present time.

It is suggested to eminent examiners, among other things, that such a question as "Why is the Parthenon beautiful?" is a much more vital one than in what technical terminology pedants would describe it, or how many columns compose the portico, and other like trivialities; and he adds that "until we seek to study the reason why things are beautiful we shall never know how to design."

Various estimates will be put by architects on the value of the opinions expressed in this rather radical essay; but all will agree that the paper is widely suggestive, and that the points made in it are such as may be profitably considered by all who desire architecture that will not only be characteristic of the present age, but which shall be beautiful as well.

Architects' Fees.

A BRIGHT young man from the country having registered as a student with a city physician was set at work by the latter to making out bills of those who were in arrears on the physician's books. After several days of this distasteful labor the embryo doctor ventured, in a timid way, to ask his preceptor when the study of medicine would be likely to commence. Thereupon the old doctor thundered at him:

"You have already begun, and are making good progress. The most important thing in medical practice is to know how to charge for services."

The theme of an editorial article in the *British Architect* relates to a similar important element in the practice of the profession of architecture. The position is taken that the system of percentages on outlays is, in a sense, a survival of the fittest, and, as such, is likely to be maintained even in the face of what the author is pleased to style, "much severe criticism." Starting with this proposition, the article proceeds to discuss the merits of the system, as contrasted with methods of compensation in other professions. The author claims that, while the system is liable to abuse, the main body of architects are "quite as upright in their desire to serve their clients to the best of their ability as are members of the legal profession, whether solicitors or barristers."

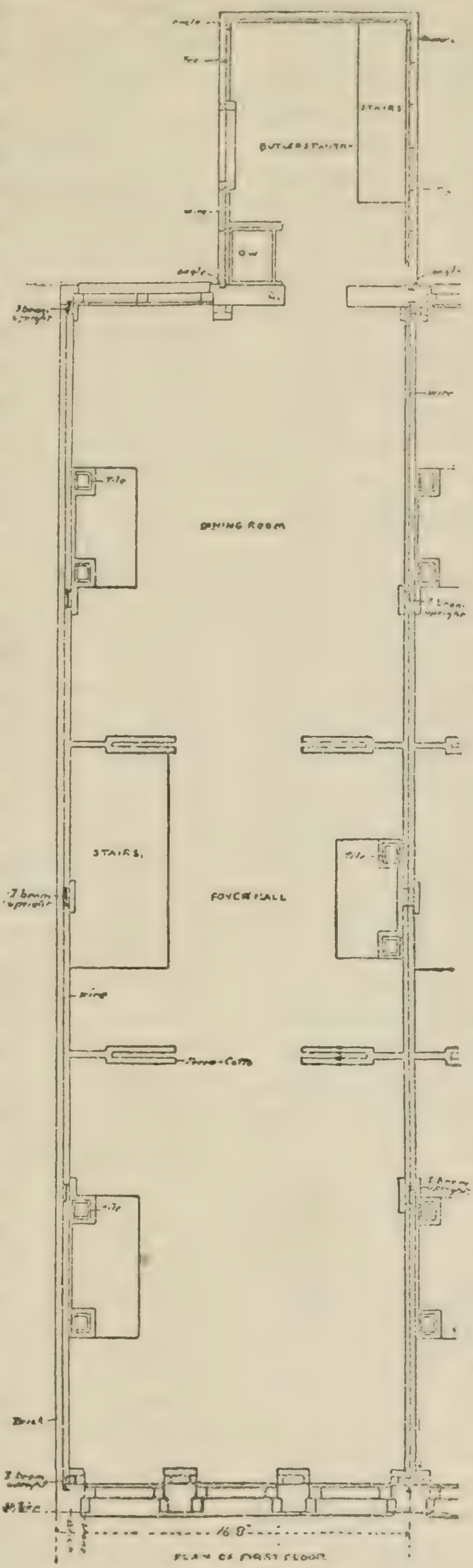
The impression that architects, worthy to be so called, are overpaid for their services, is, in view of the laborious and exacting character of their work, emphatically denied.

The cutting of percentages to figures below the standard, is discussed, and regarded as a mistake, even when practiced by a beginner desirous to gain a business connection. Another mistake distinctly pointed out is the commencement of work without some memoranda regarding the fees which will prevent disputes. A pleasant and instructive account of a futile attempt to reduce an honest bill for services rendered by a young practitioner who resisted it with firmness and success very appropriately illustrates this point.

Iron Construction Applied to City Dwellings.

THE tendency to the increased use of iron in the construction of buildings makes any real contribution to knowledge of the subject of importance and interest. It has been popularly supposed that, as compared with ordinary materials for the construction of the smaller class of buildings such, for instance, as city residences, iron would prove so much more costly as to render its use impracticable. This, however, is shown to be erroneous in *Architecture and Building* by a practical example of such construction, described with illustrations of details in the article whose title is given above. Mr. Manly M. Cutter, a New York architect, prepared plans for three ordinary city houses to be erected chiefly of iron, brick and terra cotta, in accordance with the building laws of New York city; and to cost, as nearly as possible, the same as buildings of the ordinary kind. The three buildings are designed to be erected on two adjoining city lots, each twenty-five feet in width. The complete specification for the buildings forms a part of the article.

Estimates for the construction having been obtained for this specification, and also for the ordinary construction of brick with timber beams, etc., it was found that the difference in cost of the iron construction over that with usual materials is only $211.66 for each house a result which justifies the conclusion that the projected innovation sets the pace for an improved and safer method of city residence building, reached at a merely nominal increase of cost. A plan of the first floor is herewith reproduced; and a portion of the specification that indicates in how far iron enters into the construction, is also given in the following ab-



IRON CONSTRUCTION IN CITY RESIDENCES.

struct. Below the underside of the basement the structure is wholly of brick or stone.

Outside Walls.—On top of walls at the under side of basement floor place cast iron plates for steel uprights of main building and extension. These uprights will be in the main building of wrought steel I beams, carried up to the under side of roof beams in manner shown. Between these uprights, for the support of each floor and roofs, place a wrought steel I beam girder. Between the uprights and girders stretch a woven wire screen fastened to uprights and girders in manner shown. For extension erect the uprights of tee and angle irons. For the support of floors and roof fasten to the uprights an angle iron as shown. Between the uprights and angle iron stretch a woven wire screen fastened to the uprights and angle irons.

Floors and Roofs.—On top of the cellar walls and at girders of main building and extension set the steel floor beams for each floor and roof. From the top of beams suspend and fasten a woven wire screen ; fill in between beams and on top of wire screen with concrete 3 inches above top of beams and 1 inch below center of wire screen, or as shown. On the under side of beams stretch the metal lathing and cover the same with plaster. On top of concrete insert wooden furring strips for the rough floor.

Brickwork.—For the independent walls of main building and extension build up on the outside of wire screen from the top of cellar wall to within three inches of top of roof beams, 4 inches of brick, laid in cement. Above this will be built the coping walls. All to be thoroughly anchored. Top out the chimneys as shown above the roof.

The front and rear walls of main building to be built in the usual manner of stone and brick.

Roofs.—To be boarded and tinned in the usual manner ; bluestone coping for coping walls and chimney caps. Galvanized iron gutters, conductors and cornices.

Caisson Foundation Piers.

The *Scientific American* has printed an article dealing with the increasingly important subject of foundations for tall buildings. The particular building whose caisson foundations are described, is notable as being one of the tallest yet erected in New York city. Engravings showing the building as it will appear when completed, the work in progress, and details of its construction illustrate the description, which is non-technical and written in a popular style. The foundations of the piers are carried down to bed rock by means of caissons employed in a manner entirely analogous to that adopted for the towers of the celebrated New York and Brooklyn Suspension Bridge and other noted works, in which no excavation is made except from directly under the caissons, and the material so excavated is taken out through air-locks. A particularly interesting feature of the work, in the special instance cited, is the constant maintaining of so high a pressure in the caissons as practically to squeeze the water from the excavated material, which is thus taken out comparatively dry, and the foundations of adjacent buildings are not endangered.

INDEX TO LEADING ARTICLES.

*24206. Recent Architecture in Philadelphia. Ill. W. P. Laird (E Mag–Oct.) 3000 w.

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24786. Specification Writing. T. Roney Williamson (A A–Began Sept. 1—2 parts to date—15 cts. each).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Improving the Erie Canal.

THERE are many who regard the deepening of the Erie Canal, connecting the city of Buffalo with the head of navigation on the Hudson river at Albany and Troy, a work that should be undertaken by the State of New York without any delay. The project is under consideration by the Constitutional Convention now sitting at Albany, and the Marine Record gives an abstract of an estimate transmitted to this body by State Engineer Adams. The proposal is to deepen the canals of the state to nine feet. State Engineer Adams says:

> To raise the water surface of these canals two feet would probably cost three times the amount of the estimate as shown, and to lower the bottom two feet would unquestionably increase the estimate ten fold as it would necessitate taking down and rebuilding nearly every structure on these canals. It would hardly seem that either of these latter plans would be judicious in view of their great cost and the comparatively small benefits to be derived therefrom, as it would in either case still be necessary to transfer all cargoes from lake ports at Buffalo the same as under existing conditions.

The estimates here referred to are understood to be those hitherto made for raising the banks one foot and deepening the bottom one foot, thus gaining two feet upon the present depth. The estimates of cost for the several canals in the state to secure the requisite depth are as follows:

Erie Canal....	$5,310,000.00
Oswego Canal..........	1,208,000.00
Champlain Canal.......... ...	4,300,000.00
Black River Canal............	8,880,000.00
Cayuga and Seneca Canals.....	260,000.00
Oneida River Canal...........	335,000.00
Total....................	$20,293,000.00

The above estimates contemplate the most permanent work possible, to the end that the cost of repairs shall be reduced to the minimum.

The report admits that boats carrying the same load as now could, with this improvement, save nineteen hours between Buffalo and West Troy; and that single boats could carry twenty-five tons more load than at present and yet save six hours in transit, with the same draft on horses as is now required.

With reference to propellers it is also admitted that greater power would be obtained from their deeper immersion.

The report goes on to say that "no lengthening of locks has been done on any of the canals except on the Erie and Oswego canals," and that "the probable cost of lengthening all locks on the Erie and Oswego, not already uniformly lengthened, is easily obtainable."

Of the thirty-three locks on the Erie Canal out of the total of seventy-two which have not already been enlarged the cost of enlargement is estimated at an average of $35,000 for each lock. On the Oswego Canal, out of eighteen locks, eleven have been enlarged, and the estimate for enlarging the remaining forty-three locks is $2,755,000.

State Engineer Adams expresses the opinion that any plans for canal improvement more radical than the one first above mentioned and "less radical than for a ship of twenty feet draft would not produce results commensurate with their cost." He promises to make a special report on the cost of such a ship canal in the near future.

A Necessary Drainage Project for Manitoba.

THE great savannahs lying between Lakes Manitoba and Winnipeg constitute a vast morass whose effects upon climate are noted by Mr. J. Bawden in an attempt to indicate advantages that would follow a drainage system proposed and advocated by him in the article under review printed by the *Canadian Engineer.* He asks:

"Can there be any doubt that over this vast wet blanket of country the great evaporation in progress in July and early August converts the region into a refrigerator whence icy currents move southward over the ripening wheat fields?" The position taken in the article is that "arterial drainage" is the only means whereby this cooling and frost-breeding effect can be lessened.

It has been proposed to utilize for power purposes the rapids of the Assiniboine river, on the west end of Red river, north of Winnipeg. The writer of this paper takes the ground that the erection of a dam for such a purpose would be likely to increase the damage from frost by reason of the subterranean back water it would cause.

Also it has been proposed to build a lock to admit the passage of vessels from Lake Winnipeg to the city of Winnipeg. This scheme, the writer maintains, has been advocated, without proper knowledge of the situation. On this point he says:

> The latter project has not been discussed, so far as the writer is aware, with a full comprehension of the facts. The most striking phenomenon confronts us at the outset of enquiry. The volume of water flowing in the Assiniboine river is at several points in its course very much larger than is discharged into Red river at Winnipeg.
>
> Prof. H. Y. Hind, in his report of the Assiniboine and Saskatchewan Exploring expedition, 1859, gives the following figures:

VOLUME OF WATER IN THE ASSINIBOINE.

	Cubic feet per hour.	Distance from Fort Garry.
Lane's Post...	5,702,400	22 miles.
Mouth of Little Souris..	12,899,840	140 "
Opposite Mt. Ellice....	9,979.200	289 "

> The existence of one or more subterranean discharges into Lake Manitoba is alleged. An effort to drain a tract in the vicinity of Long Lake near Poplar Station, by cutting an outlet into the Assiniboine has, in accordance with traditions of a contrary current there, proved abortive. Prof. Hind's report credits Rat river with carrying the freshets from the Assiniboine into Lake Manitoba. At page 71, he states that "down its valley the water of that river (the Assiniboine) during freshets, flows into Lake Manitoba, and by making a very shallow cut a permanent communication in time of high water could always be maintained."

Lake Manitoba being about 40 feet higher than Lake Winnipeg, in a distance of 40 miles, Mr. Bawden is of opinion that "a canal water-way can be constructed between the larger lakes, the motion of which would be of incalculable benefit to the province." It must be admitted that the arguments employed to sustain this proposition are forcible, in view of the peculiarities of the water system of the region which are pointed out. In conclusion Mr. Bawden says:

> The reclamation of some four thousand square miles of excellent land, now too wet for cultivation, well merits the immediate attention of Mr. Greenway's government. The future of silent leagues of prairie has been given over to the landgrabber, and the homeseeker is invited to move on from Manitoba to the cheaper land in the territories. It will be a fine stroke of enterprise to divert a part of the waters of the Assiniboine by canal into Lake Manitoba, and thence by a canal from this lake into Lake Winnipeg, to drain an immense area of fertile soil and mitigate the rigors of the climate. The enterprise will be all the more successful if the land reclaimed shall be thrown open to free settlement. Manitoba wants men rather than capital for the development of her vast agricultural wealth. Capital has been sufficiently invited to sit down in the prairie province, with the result that it holds millions of unproductive acres, and waits to prey upon the vitals of the laborer who alone can make the possession productive.

The Goulburn River Weir, Victoria.

In many parts of the world a serious difficulty to be contended with lies in severe and protracted droughts. This difficulty has been so formidable in Australia that in 1884 a Royal Commission was appointed to investigate the subject, and in their report the commissioners emphasized the fact that "on water conservation mainly depends the prosperity and development of the whole extent of the central and western divisions of the colony." This was followed by a report from Mr. H. G. G. McKinney, the government engineer, detailing results of the investigations and advising a scheme for storing and distributing the water of the upper Murray river at a cost, including distributing works, of £1,412,250. The delivery contemplated in this scheme was the enormous volume of 155,520,000 cubic feet per day; or a mean rate of delivery of 1800 cubic feet per second. It was also estimated that this amount of water would irrigate 270,000 acres; that it would yield a gross revenue of £177,500 a year, and a net profit, after allowing for both interest and repairs, of £100,000 annually.

Hitherto irrigation works in Australia have been mainly private enterprises, and this seems to be about the first example of works constructed for the purpose by the government. The scheme, as originally proposed by Mr. McKinney, has been extended to provide a supply for the irrigation of 775,000 acres. Enough has now been said to indicate the importance of the work.

The means for conserving the water of the Goulburn river, a tributary of the Murray river, is a weir 695 feet long, which, together with the channel regulators employed, 230 feet long, make a total length of 925 feet. The weir is composed of large blocks of concrete "banded together, bedded and jointed with cement mortar," says *The Engineer*, this being preferred to monolithic construction on account of the cracks that inevitably develop in large masses of monolithic concrete.

The waterway in the upper portion of the weir is occupied by twenty-one floodgates, each having a clear opening of 20 feet and a vertical depth of 10 feet. These, when required for the escape of flood-water, can be lowered into recesses in the body of the structure, and can be adjusted so as to maintain the water level at the off-take at the normal level. The frames of the gates are rolled T-iron beams, having 7-inch section in the tables with ¾ inch web. They are 13 inches deep at the center, curved to 8½ inches at the ends. The frames are filled in with cast-iron plates; each gate weighs seven tons. They are worked by screw gearing, carried on the gangway of the bridging, and actuated by three 30½ inches Leffel turbines. The turbines can be worked together or separately, and any or all of them can be brought into gear with any of the gates. The head available for working the turbines varies from 3 feet to 13 feet, giving 3 horse-power, with 78 revolutions per minute, to 27 horse-power, with 163 revolutions. Hand gearing to each gate is also provided in case of accident. For the purpose of working the gates in case of sudden floods coming during the night, an electric plant of five arc lamps, each of 2000 candle power, has been provided. The dynamos are worked by a 23-inch turbine.

From the above quotation it will be seen that this work, begun in 1867, and now substantially brought to completion, is entirely up to date in methods, means, and appliances. The article is based on a report prepared by Mr. Stuart Murray, Chief Engineer of Water Supply, and published at the cost of the Victorian government. This report was prepared with the expectation that it will prove serviceable to engineers and in order "that the details of a work sô important and costly may be subjected to the fullest and widest criticism. A table of the cost of different parts of the work, as excavation, masonry, etc., is embodied in the report."

Diagram for Calculating Length of Covers for Plate Girders.

A SHORT paper printed in *Engineering News* contains a valuable diagram. The text explains that the diagram was prepared for use in the works of the Dominion Bridge Company, and tells how to use it. The diagram, herewith reproduced, is based upon the principle that "the bending moment at any point of a uniformly loaded girder is measured by the ordinate through that point of a parabola whose axis is the vertical through the center of the girder, and whose base is the horizontal line between the points of support. The diagram therefore consists of a series of such parabolas from which the lengths of cover plates can be easily found." The facility with which this diagram can be used must commend it to all who examine it.

Any boy who knows the fundamental rules of arithmetic could be taught in a few moments how to use it accurately and readily. The diagram is here too much reduced in size to be convenient for use, but its reproduction will serve to illustrate its value.

"*Example.*—Suppose the section at the center is 38 square inches and the cover plate is 16 inches × ½ inch = 8 square inches. The difference is 38 — 8 = 30 square inches. On the diagram the horizontal line through 30 intersects the parabola through 38 at 0.46 from the end. If, then, the span of the girder is 60 feet, the length of cover plate will be 60 × 0.46 + 2 feet for rivets = 29 feet."

Methods of Testing Hydraulic Materials.

CONSIDERING the fact that hydraulic mortars and cements have so long been known and used, and their qualities have been so much studied, it seems at first thought surprising that there should yet be anything relating to their practical employment remaining to be found out, or that anything new or important could be said or written upon the subject of testing these materials. The fact is, notwithstanding, that the phenomena which takes place during what is called "setting" are yet subjects of speculation to some extent; and that researches are still directed to clearing up some of the peculiarities in the behavior of these substances. H. le Chatelier has contributed a paper to *Annales des Mines*, discussing methods of testing which indicates some of the tricks and manners of hydraulic materials. An abstract of this paper is reprinted in the *Engineering Record*.

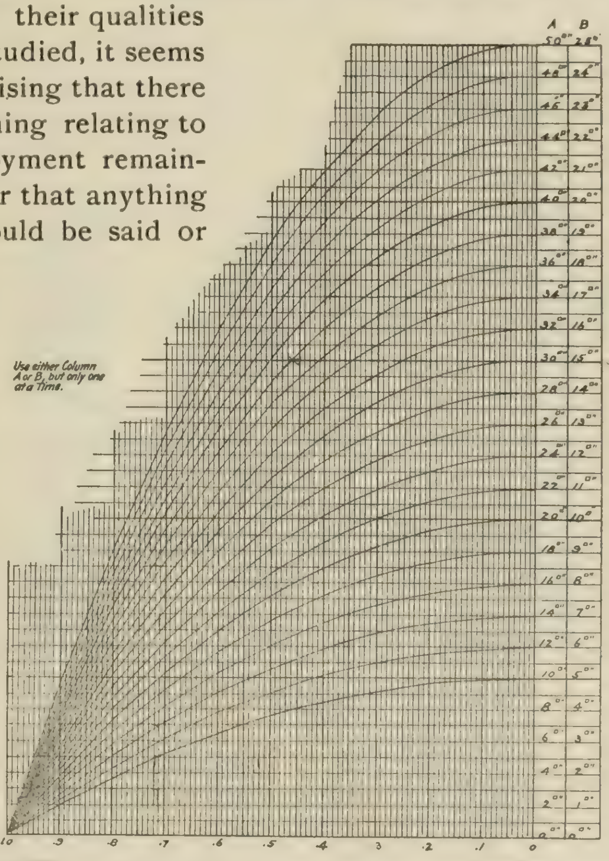


DIAGRAM FOR DETERMINING THE LENGTH OF COVER PLATES FOR PLATE GIRDERS
T. Kennard Thomson, Chief Engineer Dominion Bridge Co.

While a chemical test with most substances used in industry, indicates their value quite conclusively, such an analysis cannot prove that a hydraulic cement is of good quality, though "it might demonstrate that a certain product is undoubtedly bad. For instance, a deficiency of silica or alumina will show that the cement is not sufficiently hydraulic. The chief utility of the chemical analysis of cements is, however, to indicate the presence of injurious substances such as sulphate of lime, or sulphides. The paper is full of valuable suggestions. The author says "the relation of crushing to the tensile strength, is not a fixed quantity, but the former is generally about ten times that of the latter. With increased age the crushing strength becomes greater in proportion to the tensile." In crushing tests erroneous results may be indicated through failing to get parallelism between the surfaces subjected to pressure. Owing to sources of error in cushing machines, the author concludes that it would be premature to substitute crushing for tensile tests, although he has himself constructed an apparatus for such tests, in which some sources of error previously existing are removed.

This most exhaustive of recent essays on testing cements finally brings us to the conclusion that, "neither for resistance to sea-water nor for adhesion is the present state of knowledge sufficient to institute satisfactory tests"; yet a careful perusal of the paper cannot fail to lead to more refined methods than are often practised, and thus to general advance of knowledge upon a confessedly difficult subject.

Cleaning Water Mains.

CONCERNING some devices for effecting this important kind of work without which the capacity of water mains may in many situations become seriously impaired, Mr.

Herbert Henderson, Assoc. M. Inst. C. E., writes interestingly in an illustrated article printed in *The Railway Review*. The cuts illustrating the machines described have been kindly loaned to us by the publisher and are herewith reproduced.

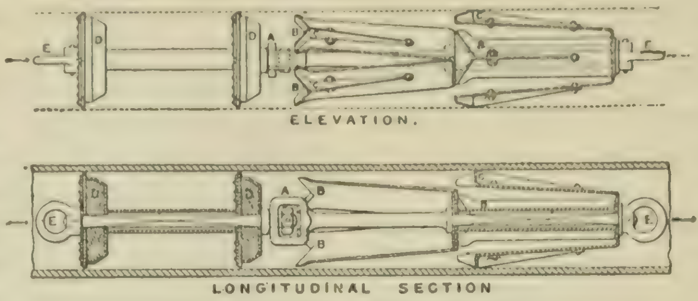


FIG. 1—WATER MAIN CLEANER.

Figure 1 is the longitudinal scraper designed by Apold, and subsequently modified by Kennedy. "It consists of two distinct portions connected by a swivel joint *A*; the front, carrying the steel scrapers, and the rear the wrought iron or steel propelling pistons. Leather disks intersected by radial cuts and stiffened at the back by lead plates, are placed behind each piston. The springs *B* with steel scraping edges *C*, are arranged in two sets of four each, the set behind breaking joint with that in front. For larger sizes the form shown in Figure 2 is used.

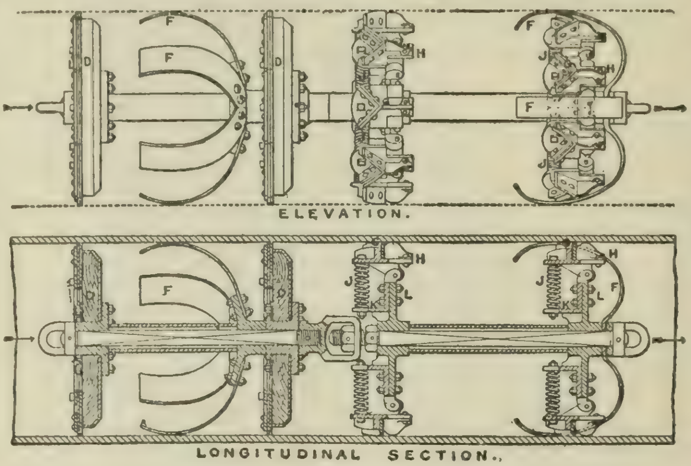


FIG. 2—WATER MAIN CLEANER.

The weight is carried by the curved steel springs *F*, one set at each end of the machine. The construction of the pistons, leather disks, and the connection between the front and rear portions, are similar to that of the smaller machine. The scraping knives are fixed to rocking brackets *H* pivoted to disks *L* attached to the center rod, and are forced against the interior surface of the pipe by spiral springs *J*, which are fixed at one end of the brackets *K* carried by the same disks *L*.

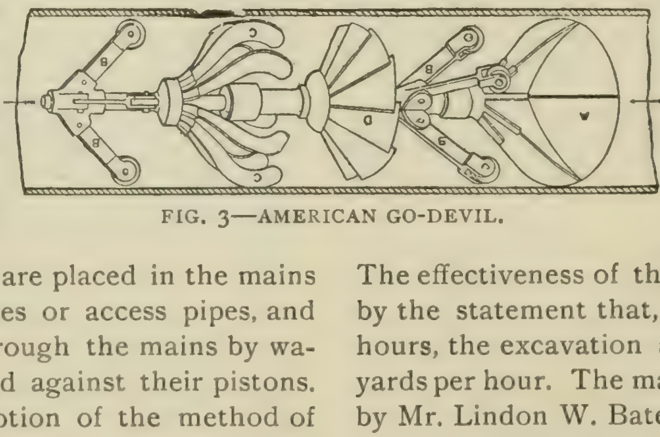


FIG. 3—AMERICAN GO-DEVIL.

These machines are placed in the mains through hatch boxes or access pipes, and they are forced through the mains by water pressure exerted against their pistons. A detailed description of the method of using is given in the article quoted. Figure 3 illustrates a device used for cleaning out oil pipes. The author does not know whether or not the latter has also been used for cleaning water mains.

THE indexed article entitled "The Hydraulic Dredge on the Chicago, Drainage Canal," with the pictorial inset completely illustrating the machine and its details, printed in *Engineering News* is an interesting description of a particular example of a very important class of machinery employed in river and harbor work. "The feature of principal interest is the cutter, a hollow steel cylinder 5 feet in diameter and 4 feet long, armed with steel knives. These knives are so inclined as to throw the material inward toward the opening of the suction pipe as the cutter advances. The suction pipe is 20 inches in diameter and both it and the shaft which operates it are carried by the '*ladder*' which takes the place of the dipper boom in an ordinary dredge, and has a length of 39 feet." The suction pipe is connected at the top of the ladder to the cast-iron pipe on the barge, by a vertical telescope joint. The effectiveness of the machine is shown by the statement that, in a run of 230½ hours, the excavation averaged 446 cubic yards per hour. The machine was designed by Mr. Lindon W. Bates, President of the American Hydraulic Dredging Co.

The Cape Hatteras Lighthouse.

According to Mr. W. M. Patton in *The Engineering Record* (August 11), a lighthouse "must and will be constructed on Diamond Shoals, off Cape Hatteras, on the Atlantic coast." He also says that only one determined effort has been made to erect this structure, which, as is well known, proved a disastrous failure. The method of letting the contract for so important and difficult a work is criticised adversely. It appears that the lowest bidder was awarded the contract in accordance with the statute, out of three who offered to erect the structure, and there does not seem very solid ground for this criticism. That there is sufficient skill, ability and experience among American engineers to erect a structure "even on that stormy coast," is the belief of Mr. Patton, and he thinks few engineers in the country would be prepared to admit that there is not sufficient engineering knowledge and skill to accomplish this feat, notwithstanding that so able and experienced a firm as Messrs. Anderson and Barr have expressed, in the same journal, the view that it was next to impossible to construct a lighthouse on the plans approved by the lighthouse board. Mr. J. F. Anderson, writing on the part of the above named firm says, that although dozens of plans, some quite complicated, have been shown him, and although their authors had confidence that their plans would be successful, "when the conditions against which they would have to contend were shown them they weakened; at least none has offered to back his project substantially." Mr. Patton claims to have designed a form of "temporary protection by which the force of the waves will be greatly reduced, scour will be prevented, comparatively quiet water produced over a certain area, the work and workmen protected from heavy seas, and the work proceeded with without danger." He asserts that he has submitted this design to several engineers and builders of experience, also to two accomplished seamen of skill and ability, as well as experience, and that they have endorsed it unqualifiedly. In Mr. Anderson's letter replying to Mr. Patton he expresses skepticism as to the advice and endorsement of sailors on such a work as this. He claims that the records at the signal office at Hatteras show that there had been no such storm in the month of July during eight years as the one his firm encountered in the effort to construct the lighthouse above referred to. And he also adds that a captain of a vessel which lay in Pamlico Sound, at Ocracoke, told him "it blowed so hard that he was unable to walk from the stern of his vessel to the bow without pulling himself along the rail." Much may be learned from the letter of Mr. Patton and Mr. Anderson's reply thereto relative to the great difficulties which must attend any attempt to erect a lighthouse on this site.

The Board of Experts' report on the Hudson River Bridge at New York city is the most important engineering document that has recently been printed. *Engineering News* publishes it substantially as it came from the Board. The report pronounces either a cantilever or suspension bridge practicable from an engineering point of view, but a cantilever of 3100 feet clear span would be impracticable financially on account of its great cost, though it could be made perfectly safe. A suspension bridge could also be made a safe structure; but its cost would be about one-third more than that of a cantilever bridge of 2000 feet span. The experts decline to state that the greater cost of the suspension bridge should put it out of consideration as a financial scheme, in view of other advantages it possesses, and also in view of contingencies that will have to be met in constructing the deep-river foundation of the proposed cantilever bridge.

Various kinds of roads, their comparative value for service and their construction having been treated in two previous articles of this series, the writer, M. W. H. Breithaupt, discusses in this concluding paper in *Canadian Engineering* the subjects of cost of roadmaking and keeping roads in good repair. Statements of cost made from cost records in various localities are interesting. Cost of gravel roads is given as from 13 cents to 50 cents per square yard, and even more in some localities and under peculiar conditions. Broken stone roads will cost $2640 and upwards per mile of 16 feet width. To get best service out of roads a system of "continuous maintenance" should be adopted, that is, a system that will promptly remedy all defects as they are developed by use. The various means and appliances for doing this work are discussed together with methods of using them, including road scrapers, rollers and hand rammers, the latter being very useful in levelling down small inequalities.

INDEX TO LEADING ARTICLES.

Bridges.

24382.—$1.50. Failure of a Masonry Pier and a Rock Foundation. Ill. William Barclay Parsons, with Discussion (T C E–June.) 2200 w.

24383.—$1.50. The Reconstruction of a Portion of the Substructure of the Johnsonville Bridge. Ill. Walter H. Gahagan, with Discussion (T C E–June.) 7000 w.

24525. Diagram for Calculating Length of Cover Plates for Plate Girders. T. Kennard Thomson (E N–Aug. 23.) 200 w.

24539. The Winona Bridge. Ill. (E R–Aug. 25.) 1200 w.

24873. Experts' Report upon the Proposed Hudson River Bridge at New York (E N–Sept. 6.) 8000 w.

Canals, Rivers and Harbors.

24215. Can the Nicaragua Canal Company Transfer its Property to Foreigners? (M R–Aug. 10.) 1000 w.

24230. Improving the Erie Canal System (M Rec–Aug. 9.) 1200 w.

†24544. Inundation Canals.—Excessive Silting Merely a Popular Fallacy. E. A. S. (I E–July 21.) 800 w.

24818. Progress of the Work on the Drainage Canal. U. W. Weston (R R–Sept. 1.) 2000 w.

24874. The Bates Hydraulic Dredge on the Chicago Drainage Canal. Ill. (E N–Sept. 6.) 1100 w.

*24880. The Chicago Inter-Land Canal (I S F–Sept.) 1500 w.

†24897. Canal du Havre a Taucaville. A. W. S. (I E–Aug. 4.) 600 w.

*24914. The Manchester Ship Canal.—Half-Yearly Meeting (E–Aug. 31.) 1800 w.

*24939. The Harbor and Dock Improvements at Portsmouth (Tr–Aug. 31.) 1300 w.

Hydraulics.

*24253. Nile Reservoirs and Philæ. Ill. (E–Aug. 3.) 1100 w.

*24262. The Goulburn River Weir, Victoria. Ill. (Eng L–Aug. 3.) 1400 w.

24276. A Necessary Drainage Project for Manitoba. J. Bowden (C Eng–Aug.) 800 w.

†24378. Project for Utilizing Bassasseachic Falls. Ill. Edward D. Self (S M Q–July.) 3000 w.

24386. A Mathematical Investigation of Stand-Pipe Failures. E. C. Murphy (E N–Aug. 16.) 500 w.

24540. Methods of Testing Hydraulic Materials. (Abstract.) H. le Chatelier (E R–Aug. 25.) 2400 w.

Miscellany.

24243. Colorado Roads and Scenery. Ill. Edward B. Light (G R–Aug.) 2800 w.

24288. The Cape Hatteras Light House.—Communications from W. M. Patton and John F. Anderson (E R–Aug. 11.) 4500 w.

24380.—$1.50. Address of President William P. Craighill at Niagara (T C E–June.) 5400 w.

24492. Cleaning Water Mains. Ill. Herbert Henderson (R R–Aug. 18.) 700 w.

24503.—75 cts. A Proposed Formula for White Pine Posts. James H. Stanwood (T Q–April.) 200 w.

24559. Roads in the Yellowstone National Park. Ill. Hiram M. Chittenden (R M–Aug.) 5000 w.

*24732. Good Mortars; Their Cost, Strength and Durability. How to Mix Properly. R. N. Buell (B B–Aug.) 1000 w.

24792. The History and Construction of our Highways, and Who Should Build Them. N. G. Spalding (G R–Sept.) 1700 w.

24798. The Roads of Fairmount Park, Philadelphia. Ill. (E R–Sept. 1.) 1500 w.

*24921. The Alignment of Tunnels. Editorial (Eng L–Aug. 31.) 2000 w.

Serials.

21592. The Harlem River Speedway (E R–Began April 28—7 parts to date—15 cts. each).

22793. Road Engineering. W. H. Breithaupt (C Eng–Began June—Ended Aug.—3 parts—15 cts. each).

23669. Centrifugal Pumps. Ill. John Richards (I S F–Began July—3 parts to date—30 cts. each).

24032. Road Making in the South. W. E. Voorhees (T–Began Aug. 1—3 parts to date—15 cts. each).

24421. Notes on the Strength of Framed Structures as Affected by Elasticity. C. F. Findlay (Eng. L–Began Aug. 10—2 parts to date—30 cts. each).

24476. Books on Bridges. Henry S. Jacoby (R G–Began Aug. 17—2 parts to date—15 cts. each).

24589. The Value of a Water Power. Charles T. Main (M G–Began Aug. 25—Ended Sept. 1—2 parts—15 cts. each).

DOMESTIC ENGINEERING

Plumbing in Mr. C. P. Huntington's Residence, New York.

An example of plumbing carried to the highest plane of perfection the art has yet attained is found in the residence of the New York millionaire named in the above title. This magnificent piece of work is to be fully described in detail in *The Engineering Record*, with engravings which reproduce working plans.

The first installment of this description, already published, gives the general features, and it appears that nothing money can procure, or mechanical skill can devise or execute has been omitted in the execution, by a well-known New York sanitary plumbing firm, of this notable piece of work. Of course this review cannot deal with the details of the work; these must be sought in the indexed article. It will only be attempted here to give some idea of its magnitude and quality.

The sanitary arrangements are extensive and complete, conforming to standard advanced metropolitan practice, and embrace kitchen, laundry, and bath and toilet-room service, besides an extensive swimming pool and Turkish bath installation, and the necessary heating boilers, tanks, filters, and pump connections which comprehend a more complicated and extensive system than is provided in some important public edifices. An Ericsson hot-air pumping engine supplies a roof-tank which supplies tank pressure for the upper stories of the building. Besides the pumping engine named there is an auxiliary electric pump, and a double acting Douglas hand pump.

Three-inch water supplies are taken from the street mains on Fifth Avenue and Fifty-seventh street, and each is connected with a 2-inch Worthington meter with inlet and outlet valves. These meters are directly connected by a 2-inch pipe with check valves at each side so that the water cannot escape from one meter through the other. The entire supply can thus be drawn from either main, or the supply for the swimming bath can be drawn from either main, and the rest of the supply from the other main. Alongside each street pressure pipe is an equal sized tank-water cold supply pipe, a hot-water supply and a ¾-inch circulation pipe under both street and tank pressure, making a group of six parallel adjacent pipes on all lines, which are generally carried up in boxes in wall recesses which are afterwards covered with wire lath and inaccessibly plastered in. At the foot of each riser is a controlling valve, and just above it an emptying valve and waste pipe.

Each vertical pipe terminates in an air chamber on top and just below it, on the hot-water pipes, is branched off the circulation return pipe. Then at each floor served, branches from both hot pipes are connected to a cut-off valve from which the distribution branch is taken. Similarly the cold-water tank and street pipes are connected to a cut-off valve from which the distribution branch is taken. All the cut-off valves are set so that when their handles are turned to the right tank pressure is on and street pressure is cut off. When they are turned to the left street pressure is on and tank pressure is cut off, and when they are turned half-way, so as to be at right angles to the wall, both street and tank pressures are cut off.

In the second and third stories are six porcelain roll-rim decorated bathtubs on marble legs, and in other stories are three porcelain-lined roll-rim cast-iron bathtubs. In the boudoir bath-room is a decorated porcelain roll-top sitz bathtub with silver-plated fittings. The other tubs are plain, with nickel-plated fittings, and the bathrooms are finished with white marble and ceramic tiles. On the first floor is a swimming bath, needle bath, shower bath, and two shampoos. In the laundry are four white porcelain washtrays.

This sufficiently indicates the character of the appliances, and those who desire to inform themselves further as to details will find them an interesting study in the art of modern sanitary plumbing.

Nature and Art.

A paper contributed to the *Revue Horticolé*, referred to in *Garden and Forest* editorially, has been prepared by M.

Edouard André, who has the honor of being considered the most distinguished living representative of the art of gardening in Europe, according to the publication last named. The paper criticises the present method of making preparatory plans in designing gardens, holding that the designers seem more solicitous about the effect of their composition as it will show on paper than as it will appear when carried out upon the ground itself. The right method, which the author states was the original method, is to search for beautiful results upon the spot itself, and not in an office. He deprecates the excessive care now devoted to theoretical drawing as leading to disillusions in actual work and predicts that this method will soon disappear in practice.

"It will be understood that the tracing of paths, which to-day is thought to constitute in itself the art of garden design, is only a portion of this art, and not the most important portion. It will be felt that, above all, varied scenes must be created within an harmonious whole, and that the means of approach to these scenes should be simply accessory."

These views of M. André are made the text of an excellent editorial in *Garden and Forest*, in which methods of design are critically discussed. Speaking of these methods, Central Park, New York city, is named as being as good an example of "artistic disposition and right relative importance of paths and drives" as can be selected.

"In view of the great beauty of this Park it is instructive to know that none was ever created in a more practical way—less in the office, more in the open air. The design of Messrs. Olmstead & Vaux, as first drawn and accepted, was very different from their design as we see it realized to-day. The former was, of course, adapted, after careful study, to the very peculiar and difficult site in view; but during the long years while the actual work progressed it was perpetually modified in deference to the minuter knowledge gained by its creators. They lived on the borders of the Park and studied its face as a portrait painter studies the face of the sitter. Day by day they reconsidered and recast parts of their scheme, and day by day they reviewed and revised their proposed emendations on the site itself. Thus a great work of art was achieved, and thus only can a great work of landscape art ever be achieved."

The article concludes with a caution against attempting too much work at once in landscape gardening. That is to say it deems it unadvisable that designers should have at the same time too many undertakings of this kind. The opinion is also expressed that no work of this kind can be done with success except through many years of personal superintendence by the designer.

Comparative Tests Between Plane and Extended Surface Radiators.

PROFESSORS J. E. DENTON AND D. S. JACOBUS, of the Stevens Institute of Technology, have recently made a series of tests with a view of obtaining data for a general comparison of the relative value, considered solely with reference to its heating efficiency, of a square foot of extended radiator surface as compared with the same unit of plane radiator surface. A description of methods employed and of the results obtained has been published by the *Engineering Record*. The editors of this excellent publication have kindly aided in the preparation of this review by the loaning of the accompanying engravings illustrating the character of the surfaces subjected to the tests, and the method employed in testing them.

It has become a matter of importance in the purchase of radiators to be able to form some estimate with reference to the heating effect of a unit of surface of any of the different extended surface radiators on the market, in order to judge wisely whether the price at which it is sold, considered with reference to its heating efficiency makes it more or less costly to use than other kinds. While the tests under consideration do not settle this point for all kinds of radiators, they are valuable, as giving results of careful experiments with severa radiator surfaces one of which is plane an of a kind generally accepted by heating engineers as of very high efficiency in transferring heat from its contained steam t surrounding air and objects. In the test the amount of steam actually condensed i the radiators is taken as the measure o external heating effect. In this way very exact determinations are possible, when sources of error are, as in this case, carefully avoided. It is necessary that only dry steam be allowed to enter the radiators under examination. To secure the result, a special separator was employed in these tests. It is also essential that all the conditions to which the surfaces investigated are subjected in the test should be exactly the same during the experiments. The following description of the arrangement of the apparatus and of the methods employed are abstracted from the article.

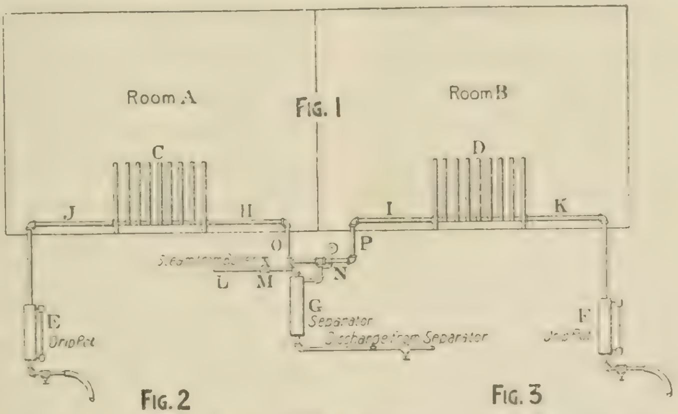


Fig. 2

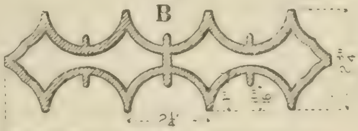
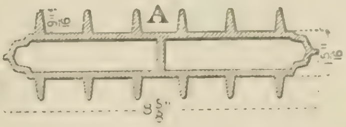


Fig. 3



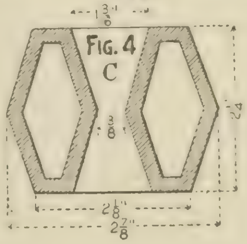
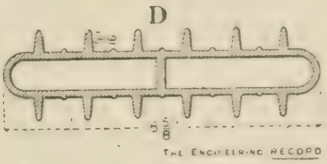


Fig. 5



The tests of the complete radiators were made by placing two radiators in adjoining rooms having the same exposure to the influence of the outside atmosphere. There was a single window in each of the rooms, which was opened a certain amount during the tests in order to maintain the temperature at some constant figure. At the top of each room was an opening for ventilation. A screen was placed between the radiators and the window to prevent a direct draft from striking the radiators. The temperature was measured at each side of the radiator. The thermometers were hung about 2 feet from the radiator, and were protected from the action of radiant heat by placing a double screen of tin between them and the radiator. In order to insure dry steam it was passed through a special separator, the blow-off valve of which was left partly open throughout the tests to make certain that no water accumulated in the steam space.

The general arrangement of the two radiators for a test is shown in Figure 1. The radiators C and D were placed in the rooms A and B. High-pressure steam from the boilers passed through the pipe L to the reducing valve M, where it was reduced to the pressure of about 3½ pounds per square inch. It then passed through the separator G and upward through pipe N, from whence it passed through the branch pipes O and P through lengths of hose H and I into the radiators. The water condensed in the radiators passed through the hose connections J and K into the drip-pots E and F. The drip-pots were provided with water glasses. All the connections and the drip-pots were thoroughly covered with non-conducting material to reduce the radiation of heat from them.

In starting a comparative test the water was brought to a certain height in the drip-pots E and F by opening the valves R and S. The valves R and S were then closed so that the water of condensation collected in the drip-pots. At the end of 20 minutes the water was drawn off from the drip-pots through hose submerged in a pail of cold water, and weighed. Each test was continued for one hour or longer, and at the end of this time the radiators were reversed so that D was placed in room A, and C in room B. The test was then repeated. An average of the results for rooms A and B gives the results of the comparative tests contained in table I.

Those who desire to avail themselves of the tabulated results thus obtained must consult the article itself. Two other tables are given which contain valuable data. It was found that the efficiency of the extended surfaces tested varied considerably. It required 1.19 square feet of one kind to condense as much steam as 1 square foot of plane surface. In another case 1.07 square feet equalled in efficiency 1 square foot of plane surface. Between these limits it will be seen there is room for considerable difference. The description of these tests is, perhaps, of greater value as instructing those in the heating trade how they can make such examinations for themselves, than its tabulated results. It is to be hoped that similar tests will also be made with indirect radiators respectively having plane and extended surface, and under conditions as nearly as possible similar to those which attend actual use in heating buildings.

Cheap Sanitation.

AN able legal editorial in *Engineering* discusses the profession of sanitary engineering, regarding it as one of very grave responsibility, as upon the results of the work of the sanitary engineer depend the lives of thousands of persons. The conditions environing the profession are very well stated :

> The art he practises is admittedly so defective that he has no choice but to try and improve it. His task is rendered more difficult by the fact that he has no pecuniary profit to offer his clients to reconcile them to a large expenditure of money. Although there has been a steady and constant progress in sanitation yet its history is largely a chronicle of the substitution of one evil for another, because individuals and public bodies would not undertake the expense of radical reforms, and refused to believe the cheapest remedies were not always the best.

The progress of sanitary engineering from the early days of the cesspool, poisoning basements of houses with leakage, "the cheaply laid sewer" which superseded cesspools but was often itself "half filled with decaying sediment" emitting "evil smelling gases," finding "direct entrance through entrapped pipes into sitting-rooms and bedrooms," and so on through all the steps which have led to the supply of purer potable water and effective drainage with vastly improved ventilation, are then traced in an interesting way up to date.

One of the most interesting features of the article is the credit it gives to the State of Massachusetts for its enterprise in founding an experimental station for the study of filtration of sewage and kindred subjects. Of this it remarks that so great has been its success that to-day no sanitarian's library is complete without the annual reports of the Board of Health of this State, "which results have not only been freely given to the cities and towns of Massachusetts but also to the world and have furnished starting points from which other workers have inaugurated researches which, otherwise, they would not have been able to undertake."

Engineering regards it as hopeless to expect that the local government board will "follow such a good example, as it is utterly opposed to their traditions." It also thinks, were this done, it would be "absolutely certain that the money would be saved many times and—what is still more important—the progress of sanitation would be expedited."

The example of Massachusetts is commended to the notice of the County Councilors in the great manufacturing districts of the north of England. The cost of the Massachusetts' experiments is held to be certainly small as compared with the cost of leaving each town to make its own inquiries and experiments. In short the example of a State Government taking up the subject of general sanitation as Massachusetts has done, is deemed highly worthy of imitation.

INDEX TO LEADING ARTICLES.

24962. Comparative Tests between Plane and extended Surface Radiators (E R–Sept. 8.) 1800 w.

24636. Nature and Art (G & F–Aug. 29.) 1500 w.

*24254. Cheap Sanitation. Editorial (E–Aug. 3.) 2400 w.

19813. American Plumbing (D E–Began Feb.—6 parts to date—30 cts. each).

24231. The Plumber and Electricity (S P–Began Aug.—2 parts to date—15 cts. each).

24434. Engineering and Hygiene (I & I–Began Aug. 10—2 parts to date—30 cts. each).

24542. Plumbing in Mr. C. P. Huntington's Residence. Ill. (E R–Began Aug. 25—1 part to date—15 cts).

ELECTRICITY

Sine Curves of Electromotive Force.

SOME weeks since the London *Electrician* remarked, in respect to alternating current curves of the true sine form, that "the elaborate attempts which are being made by some of the American builders to give this property to their machines is utterly useless and a complete waste of time and energy." In the *Electrical World* (August 25) this problem is discussed pro and con with considerable spirit by two of the leading American authorities on the subject of alternating current phenomena. Charles P. Steinmetz of the General Electric Company says that "an enormous amount of theoretical discussion has been carried on to prove the superiority of the sine-wave for motor work, for the efficiency of transformers, etc., and that mostly by theoretical men who did not have any great chance to prove or disprove their theoretical conclusions by practical experience." In support of his opinion, which agrees with that of the *Electrician*, Mr. Steinmetz gives a table of transformer tests made by himself with two alternating generators giving respectively a sine-wave and a distorted wave, which showed an average difference in efficiency in favor of the distorted wave of over 9 per cent. Tests made with a motor showed that there was no difference that could readily be detected. Hence Mr. Steinmetz concludes that "the superiority claimed for the sine-wave is a mere superstition without actual foundation." Per contra, Professor Harris J. Ryan of Cornell University inquires "whether there is any form for a standard that presents more advantages and introduces fewer constructional difficulties or expenses than the sine form?" He also points out that the sine form is a necessity in case a condenser is employed for supplying the reactance currents to the primaries of induction motors, a plan which has been definitely adopted by one of the most successful builders of alternating motors. In the same journal of September 1, Dr. Louis Bell gives the results of of some experiments of his own bearing on this subject, from which he concludes that very considerable variations from the theoretical sine form of current wave are serious in their effects. He is furthermore of the opinion that the effect of a distorted current is more to be dreaded, commercially speaking, on the line, in a case of long-distance transmission, than in the motors.

Electric Lighting in Great Britain.

ALTHOUGH in a general sense it is probably true that America is very greatly in advance of Great Britain in the diversity and extent of its industrial applications of electricity, yet a careful study of the methods and appliances used in that country reveals some points which our electricians might do worse than to imitate. In the *Electrical World* (August 11, 18, and September 1 and 8) Mr. E. Ray Stevens, of London, gives a useful résumé of the work which has actually been accomplished up to date by the various public lighting companies, with statistical summaries of their annual reports. It appears that the number of central station plants in the United Kingdom owned and operated by companies is now but slightly in excess of the number owned and operated by municipalities. The present tendency seems to be strongly towards increasing the number of municipal plants. As far as figures could be obtained, it appears that all the city plants have been able after the first year of operation to earn interest, taxes, depreciation and sinking-fund charges. In all plants, especially the larger ones, the cost of production has been very largely diminished in proportion to the amount of output, as the actual output increased. The tables given indicate that in Great Britain the municipalities have been fully as successful as the private companies in operating their plants economically. The average charge to the consumer is given as 12.10 cents per kilowatt-hour for private plants, and 11.54 cents for public plants. This is considerably below the price in this country, which may fairly be taken to be about 15 cents per k. w. h. It appears that very few cities have attempted to illuminate their streets by electricity.

Advantages of Polyphase Electric Motors.

THE fact is now generally accepted that in the transmission of power to a distance by electricity, the alternating current and the alternating motor are practically indispensable. In a paper recently read before the American Institute of Electrical Engineers, Dr. Louis Bell remarks that there has been a tendency to look upon the polyphase motor as a somewhat undesirable resort to which the electrical engineer has been driven by the exigencies of long-distance work. Dr. Bell's own experience as a constructing engineer has, however, gradually led him to the conclusion that the polyphase motor is intrinsically preferable to the direct current motor, and that it is destined to prove a formidable competitor to the latter, not alone in long-distance work, but in all the diverse applications of industry. The comparative merits of the two types of motor are discussed at length, and much interesting information is incidentally given. In its construction, the polyphase motor is singularly free from complexity; the armature winding is simple, and the commutator, a source of endless trouble in many direct current machines, is non-existent. The most powerful currents are insufficient to destroy or even cripple the motor. It is compact and convenient in form and will run equally well in any position. In large units it may be made to weigh as little as 25 to 30 pounds per horse-power. It has been found to endure complete reversal under full load within 10 or 15 seconds, this being the time required to pass from full speed in one direction to full speed in the opposite direction. It is quite insensitive to moderate variations in voltage, but by means of a rheostat in the secondary circuit, its speed may be varied with the same facility and within the same wide range as that of a series-wound direct-current machine.

Cable from New York to Europe.

THE numerous inconveniences incident to the maintenance of land line connections between New York and the eastern coasts of New England and Nova Scotia, have induced the Commercial Cable Company to try the experiment of extending their submarine cable through salt water directly to the Battery, at the southern end of New York city. The *Electrical Engineer* (September 12) contains an interesting account of this work, illustrated with engravings made from photographs taken on the spot. The laying of the shore end of the cable was completed on Sunday, September 2, and the line is now in successful operation. One of the principal recent causes of interference with the land lines has been the stray currents from the trolley railroads in Brooklyn, which at times have completely overpowered the comparatively feeble signals from the sending end of the cable.

A Model Specification for a Municipal Electric Lighting Plant.

IN very many respects, Toronto may justly claim to be one of the model municipalities of the North American continent. Having decided to establish an electric street-lighting service to be owned and operated by the city, the municipal authorities have resorted to the commendable, even if unusual expedient, of having detailed specifications of the proposed plant drawn up by the city engineer, Mr. E. H. Keating, and inviting tenders therefor from the leading manufacturing companies. These specifications are reprinted nearly in full in the *Engineering News* (August 23) and contain much matter of value to the profession. The capacity of the plant is to be 1500 arcs of 9.5 to 10 amperes and 45 to 50 volts, or what are commonly termed 2000 candle-power lamps. From 75 to 100 arcs are to be placed in each circuit. Three 500 horse-power compound condensing engines are called for, working at a pressure of 140 pounds above the atmosphere. The boilers may be either water-tube or internally fired marine boilers, of a rated capacity of 250 horse-power on a basis of 30 pounds evaporation at 70 pounds pressure, with feed-water at 100° F. Dynamos must have a commercial efficiency of 85 per cent. under full load and be capable of operating for 20 consecutive hours under such load without heating more than 70° above surrounding atmosphere. The insulative resistance must not be less than 1 megohm. Connections between dynamo and switchboard to be made by lead-covered rubber-insulated stranded cables, carried in insulated brass-covered conduits. The outside lines to be strung on white cedar poles, 7 inches thick at the top, and set 5 feet in the ground. Deep-groove glass insulators and No. 6 wire with triple-braided weather-proof insulation are to be used. A lightning arrester is to be provided for each 20 lamps. It is estimated that 220 miles of line-wire will be required. Bids are also invited for a constant-potential arc installation of equivalent capacity, including direct driven constant-potential dynamos. When this contract has been awarded, we shall no doubt be able to learn with considerable accuracy, what ought to be the cost of a first-class arc-lighting plant, of modern type. Moreover, it will be very interesting to gain some authentic information as to the comparative cost of a constant potential and a constant current installation of arc lamps for public lighting, when required to do the same work under exactly similar conditions.

The Computation of Magnetic Leakage in Dynamo-Electric Machinery.

In designing a dynamo-electric machine, the predetermination of the magnetic leakage has hitherto been regarded as a matter of considerable complexity. Professor Silvanus Thompson, who is looked upon as a leading authority upon this subject, gives in his well-known work a logarithmic formula, originated by Professor George Forbes, which is eminently calculated to strike terror to the heart of the average student, while Kapp, in his "Transmission of Energy" gives two very simple empirical formulæ, which unfortunately are of little value for ordinary purposes. In the *Electrical Engineer* (August 22 and 29, and September 12) Mr. A. E. Wiener gives a series of papers, not yet completed, in which he attempts, and apparently with success, to deal with the problem by simple mathematical formulæ which will enable the leakage factor of a dynamo to be computed for a machine of any form or dimensions within a few per cent. of its actual value. Such predetermination is obviously necessary in every individual case, because that two machines may be of the same general design and approximately of the same size and intended capacity, and yet vary widely in their leakage factor by reason of some difference in the proportion of their essential parts. Even in the same machine the amount of leakage may be considerably varied by substituting armatures of different core-diameters in the same field. To those engaged in the designing of dynamo-electric machines, Mr. Wiener's series of papers cannot but prove of great practical value.

Test of a Closed-Coil Arc Dynamo.

Considering that there are in the United States nearly 1000 central stations, operating more than 125,000 arc lamps of the type supplied by a single manufacturing company, and probably nearly or quite as many more of various other makes, it is certainly remarkable that so little attention has been paid to the investigation of the characteristics of the peculiar types of dynamo electric machines adapted to this service. Probably nine-tenths or more of the whole number of these machines in use throughout the world are of the open-coil type, but within a year or two, the remarkable effectiveness of some of the later machines of the closed-coil type, has awakened a renewed interest in the study of their performances. In the *Electrical World* (August 18) a paper giving the results of careful tests of such a machine, by R. B. Owens and C. A. Skinner, is published, which is certainly worthy of the attention of those interested in arc-lighting. The machine tested was a 25-lighter of the Gramme type. Its efficiency under full load was found to be about 84 per cent., which is remarkably high for an arc machine. The efficiency was found to fall off very rapidly with a diminution of load. The regulation for different loads was found to be principally effected by the shifting of the brushes. Graphic diagrams of electromotive force and output accompany the paper. A full abstract of this paper is also given in the *Electrical Engineer* (August 22).

Direct Current Lighting at High Pressure.

One of the most unique and technically ingenious plans for lighting a town of moderate size which has come under our notice is that which has for the past two years been in operation in the university town of Oxford, England, and was described by Mr. Thomas Parker in a paper read before the British Association, published in the London *Electrical Engineer* of August 17th. The conditions which confronted the projectors of this plant were by no means favorable to economical or profitable results, and no small credit is due to the engineers by whom they have been so successfully met. In Oxford, the principal consumers are the colleges, and hence anything like a full load can only be obtained during term-time. There is a maximum load for even half the plant only during some eight weeks of the year, and hence the system must necessarily be very elastic to be able to show even fair results. It was also necessary to locate the generating station at a distance of 4500 feet from the center of the area to be lighted, which of course compelled the employment of high-pressure currents. After much consideration, a high-pressure continuous-current plant in conjunction with motor transformers and storage-batteries was decided upon. At the power-house, the currents are generated at an e. m. f. of 1050 to 1100 volts, and are thence conveyed to a distributing station through two pairs of mains insulated with india-rubber, laid underground in iron pipes. Each motor-transformer consists of a field-magnet and an armature with primary and secondary winding, having a commutator at each end. Full details of this apparatus are given in the paper. The secondary mains are made up in two sizes in the form of armored cables. These are laid in a trench under the sidewalks, and are provided with disconnecting branch-boxes, so that any section or street can be cut out. The high-tension feeders to the transformers are of similar cable. At present seven motor-transformers are used in five sub-stations. The storage battery at the distributing station is capable of sustaining a discharge of 120 amperes for eight hours, and takes care of the load from 1 o'clock A. M. until half an hour after sunset. The battery is charged by a small motor generator, giving an output of 100 amperes and 33 volts from its secondary armature, being supplied from the secondary mains at an e. m. f. of 103 volts on its primary. The 33 volts from the secondary armature is put in series with the secondary mains, giving an aggregate of 136 volts, which is sufficient to charge the cells. This is found to be more economical than charging from the secondary mains with a regulating resistance, the total efficiency being 92.5 per cent. At the generating station, three inverted triple-expansion condensing engines are employed, running at 125 revolutions per minute, and driving three separately-excited Elwell-Parker dynamos, each having a capacity of 80 amperes at 1100 volts and 400 revolutions. These are connected to bus-bars, so as to be run singly or in parallel as required. The "load-factor" of the station works out only 5.93 per cent. By this technical expression is understood the ratio of units of current sold to units that could be sold with the lamps always on, viz.:

$$\frac{\text{Metered watt-hours} \times 100.}{\text{Mean watts installed} \times \text{number of hours in the year.}}$$

For the greater part of the year only about half load for one engine is ever required, and in view of this fact the following results of the year's working from July 1, 1893. to June 30, 1894. must be regarded as quite remarkable. The aggregate kilowatt-hours generated were 195,022 and the total metered 122,081, of which 18,303 were supplied for public lighting, and 2019 k. w. h. were used at the distributing station. The total efficiency of the system was 62.6 per cent.; that of the transformers 76.7 per cent. including losses in mains and resistances, and that of the battery 43.9 per cent. The total kilowatt-hours unaccounted for were 6976 units, or not quite 5.5 per cent. Omitting this loss in computation, the coal used amounted to 6.43 pounds per k. w. sold, costing .752 (1.5 cents) per k. w. The number of 8 c. p. 35-watt lamps installed was 5060 at the beginning and 7774 at the end of the fiscal year. The total cost of all generating expenses, including rent and taxes, was 3.715d. (7.43 cts.) per k. w. delivered to consumers. The total revenue for the year was £3715 8s. 2d. or approximately $15,000, the k. w. consumed averaging 18.2 per lamp throughout the year, for which the average price obtained 7.3d. (14.6 cts.) per k. w. h. It is doubtful if another station can be found in the world of such small capacity and with such wide variations of load in different parts of the year, which can make so good a showing.

How Shall Electricity be Sold?

THE adjustment of a scale of charges for the supply of electricity, in such a manner as to be equitable alike to the small and to the large, to the economical and to the wasteful consumer, has proved in practice to be a matter of no small difficulty. In this country it may be said that rough-and-ready methods are still permitted to prevail to a greater extent than is at all desirable, but in England the matter appears to have been much more carefully studied. In the London *Electrical Review* (July 27, August 3, 10) this subject has been somewhat exhaustively considered by Alfred H. Gibbings, electrical engineer to the Hull corporation. Mr. Gibbings reaches the conclusion that the ideal method of charging is to fix a rate per kilowatt-hour which is definite, and irrespective of the quantity of the consumer's demand; that records should be based upon the daily and not upon the quarterly consumption; that a higher price should be charged during the hours of maximum demand upon the plant, and a lower price at all other times; that the hours of higher price should be definitely fixed, but varied to meet the general lighting hours at different seasons of the year; that all consumers using current during the hours of greater demand should be charged the maximum price and all consumers at other times the minimum price; that no rebates should be allowed to any consumer, but that charges should be based upon net cost of production with a minimum of profit on every k. w. h. generated; that one pair of leads from the supply mains should carry all the current required, whether for lighting or power; and that an automatically acting meter should be provided which will register the current consumed at the higher and the lower rate respectively. Under such a system a consumer would know definitely that he could use as much current as he pleased, at the lower price, right up to the hour at which the higher charge begins to take effect. Moreover, he would know exactly what he was paying on any particular day of the year, whether he might intend to use a similar quantity on any succeeding day or not, and hence it is evident that the inducement for him to become a regular user would be much greater than would be likely with the vague and indefinite inducement of a rebate at the end of the quarter or year. Certainly no system of charging could possibly do more towards eliminating the excessive irregularities ordinarily found in station load-curves, than that of charging a higher price during the daily period of maximum demand. The concluding portion of the paper contains illustrations of a device invented by Mr. Kapp for accomplishing the result referred to, consisting of a simple shunt spanning the meter, which is opened and closed by the action of a chronometer at the proper hours. Obviously the proper ratio between the resistance of the meter and that of the shunt must depend upon the respective rates of charging for current. The discussion is one of great practical importance, and will repay careful study by central station managers.

A Technico-Legal Puzzle.

AMONG the various perplexing problems

which have arisen to vex the souls of electric railway managers in this country, there is none, it is safe to say, which has occasioned them more serious concern than that of the damages alleged to have been sustained by gas and water companies from the extensive corrosion of their pipes by the electrolytic action of the stray electric currents from the generators of the railway companies. If ascertained remedies are adopted with reluctance, or with only moderate success, an appeal to the courts will inevitably be taken at no distant day. In the *Street Railway Gazette* (August 11), the legal status of the problem is examined at some length by R. D. Fisher. Mr. Fisher refers first to the litigation between the telephone and the electric light companies. Both occupied the public highways by legal rights, the telephone having been the first comer, and its service having afterwards been seriously crippled in many places by the inductive action of the electric-light lines. In Nebraska, the courts have decided that telephone wires already in a street must be protected, to the extent at least, of compelling the electric-light conductors to be kept at a certain distance therefrom. Perhaps the most important point yet decided in the case of a telephone company against a street-railway company, is that of the Supreme Court of Ohio of recent date, in which it was held in substance that the franchise of a telephone company to use the public streets is subordinate to the right of the public therein for purposes of travel and transportation, and that these uses are materially facilitated by the application of electricity to street-railways. Now it would seem by analogy as if the same principle ought to apply to the case of the gas and water-pipes. If we assume that the public has the right to avail itself of all new and improved modes of travel which may from time to time be discovered, then it would seem to follow that a franchise granted for this purpose must confer a right paramount to the prior franchise of a water or gas company ; and hence if the operation of a street railway by electricity interferes with the working of a gas or water company, the latter must protect itself as best it can by readjusting its methods to meet the new conditions. If these conclusions are legally sound, then it would appear that the conflict between the gas and water companies and the electric railways must ultimately be settled by the ingenuity of inventors rather than by the skillful or technical efforts of lawyers and courts. The whole question nevertheless appears to be surrounded by grave difficulties, and is likely to occupy the attention of the courts to a considerable extent at no distant day.

Alternate vs. Direct Currents.

AMONGST electrical engineers there remain a few, chiefly of the old pioneers, who have not yet grasped the advantages possessed by alternate currents over continuous currents in systems of electric supply, says Professor Silvanus Thomson in his paper read before the British Association, in the *Electrician* (London) of August 24. Superstitions still linger that alternate currents are less easy to manage, or are less economical, or are more dangerous, or are less readily measured than continuous currents. There is a special superstition that they cannot drive motors. Such superstitions once set afloat, die hard. And, sad to relate, they are sedulously fostered by a few interested persons who ought to know better. The all-important fact to the electrical engineer, that the economic transmission of electric energy to long distances depends upon the use of high pressures, is absolutely independent of the nature of the current, whether continuous or alternating, but the peculiar advantage of the latter arises from the circumstance that high pressures cannot be used in houses without being transformed to low pressures, and hence a system which employs only a stationary transformer of two coils of wire wound on an iron core must be preferable to one which requires moving machinery of more or less complexity to accomplish the same end, Professor Thomson sums up the various advantages of alternating currents in a lucid and forcible manner. His remarks may be summarized by saying that all troubles arising from commutators and brushes are avoided; there is less trouble from leaks in the distributing circuit than in case of direct currents; the danger to life with equal voltage is less; alternate currents are capable of regulation by inductive resistances which do not waste energy; when applied in phasal systems, they enable a central station to furnish current from a single set of mains for almost any possible requirement; while a still further advantage about which even electrical engineers are as yet almost wholly unenlightened, is the capacity of alternatic currents to operate electro-magnets which maintain a constant pull upon their armatures through a large range; it being even possible to produce a greater pull at a distance than when in close proximity. This circumstance obviously introduces into electro-mechanism a new element hitherto undreamt of. Finally, recent researches have rendered it certain that the regulation of pressure in an extensive network of conductors, instead of being made more difficult where motors are extensively used, as was feared by some engineers, will actually be more easy, provided the motors are of the over-excited synchronous type. With such possibilities open in the future for alternate current working, and with such advantages in respect to motive-power over continuous current working, Professor Thomson thinks it can hardly be doubted that, save in a few special cases, the vast majority of central stations will henceforth be operated by alternating currents.

In the same number of the *Electrician*, the editor takes up his cudgel in behalf of the direct current and presents the opposite side of the case in picturesque and forcible language. Admitting that at least in a certain sense, the controversy between the alternating and direct current is at an end (it certainly is in the United States), the *Electrician* contends that this is not because direct currents have no chance, but rather because it is a question to be determined in each particular case, at what point on the radius from a supply station the direct current must be dropped. Professor Thomson is criticised for bracketing low pressure with direct currents, as though the laws of nature forbade a direct current of 5000 or 10,000 volts. Eighteen months ago, Dr. Fleming had proved as well as figures could prove, and as yet without refutation, that taking the all-day efficiency of a three-wire feeder one mile long delivering 24 k. w. at 200 volts, and the all-day efficiency of a 24 k. w. transformer and losses in a double 7/16 primary cable one mile long, there was practically nothing to choose between the annual costs. Nevertheless, the *Electrician* concludes that it is probable that a majority of future stations will generate alternate currents, for the reason that the larger cities have already adopted the direct current system as best adapted to their needs, leaving the promoters of alternate current undertakings to make the best they can of the less compact and less profitable territory still open to them. There is much barren soil which no direct current man cares to till, but from which the alternating man may with care reap a golden harvest. The engineering difficulties are not insurmountable, and the scientific difficulties for which such ingenious remedies are proposed, will disappear of their own accord. They are merely kept before us by scientific men who enjoy them.

Economy in the Boiler Room.

In a paper recently read before the Northwestern Electrical Association, Consulting Engineer John C. McMynn discusses this somewhat trite, but nevertheless, most misunderstood and neglected subject. He gives a well-proved formula for computing the approximate cost per horse-power of boilers under different conditions, and appends a set of tables compiled for R. W. Hunt & Co. showing the cost of evaporating 1000 pounds of water with different fuels at different prices. This paper is of no less value to managers of other steam plants as well as to those engaged in the production of electricity.

INDEX TO LEADING ARTICLES

Lighting.

24212. The Coming Electric Light (M S P–Aug. 4.) 1300 w.

24278. An English Lighting and Power Plant. James H. Killey (C Eng–Aug.) 2800 w.

*24314. The Municipal Electric Light Station at Hanley. Ill. (E E L–Aug. 3.) 3300 w.

*24422. The Electric Lighting of Portsmouth and Southsea. Ill. (Eng L–Aug. 10.) 3800 w.

*24439. The Mensing Arc Lamp. Ill. (E R L–Aug. 10.) 500 w.

*24440. The Lighting of Public Streets and the Cost (E R L–Aug. 10.) 1200 w.

24526. Specifications for Electric Street Lighting Plant for Toronto (E N–Aug. 25.) 5000 w.

24531. Association of Edison Illuminating Companies of the United States (E W–Aug. 25.) 3000 w.

24535. Incandescent Arc Street Lamps in Brooklyn. Ill. W. T. Hunt (E A–Aug. 25.) 900 w.

24553. Electric Illuminating Plant of the Herzberger Insane Asylum, Lichtenberg, Germany. Ill. (W E–Aug. 25.) 2000 w.

*24606. Continuous-Current Distribution of Electricity at High Voltage.—A Description of the Lighting of the City of Oxford. Thomas Parker (E E L–Aug. 17.) 2500 w.

24734. Electricity in Church. Ill. (E W–Sept. 1.) 1200 w.

*24776. Electric Lighting of Arundel Castle. Ill. (E R L–Aug. 24.) 2500 w.

24889.—$1. Unipolar Dynamos for Electric Light and Power. F. B. Crocker and C. H Parmly, with Discussion (T A I E E–June and July.) 8000 w.

Serials.

16631. The Scientific Study of Arc Lamps. Rankin Kennedy (E R L–Began Oct. 6, 1893—8 parts to date—30 cts. each).

22131. The Incandescence Lamp. A. Bainville (E R L–Began May 11—6 parts to date—30 cts. each).

24018. A Bolometric Study of Light Standards. Clayton H. Sharp and W. R. Turnbull (E N Y–Began Aug. 1—Ended Aug. 22—3 parts—15 cts. each).

24194. Electric Lighting in Great Britain. E. Ray Stevens (E W–Began Aug. 11—4 parts to date—15 cts. each).

Power.

*24317. Electric Power, Heating and Lighting. G. Binswanger (E E L–Aug. 3.) 1500 w.

24344. Test of a Closed-Coil Arc Dynamo. Ill. R. B. Owens and C. A. Skinner (E N Y–Aug. 15.) 2200 w.

24367. The Pittsburg Reduction Company's Electric Plant at Niagara Falls. Ill. (E E N Y–Aug. 15.) 1100 w.

†24398. Commercial Power Development at Niagara. Ill. Ernest A. Le Sueur (P S M–Sept.) 8200 w.

24637. General Electric Railroading. G. P. Hachenberg (E R N Y–Aug. 29.) 1100 w.

*24755. Notes on Electric Power, with Special Reference to Works Driven by Electricity in Belgium. D. Selby-Bigge (E E L–Aug. 24.) 1800 w.

24823. The Modern Dynamo. Gilbert Donaldson (Pr–Sept.) 1000 w.

24890.—$1. Diseases of Dynamos.—Compiled and Arranged by C. D. Parkhurst (T A I E E–June and July.) Table.

24899. Electrically Operated Factory at South Milwaukee, Wis. Ill. (W E–Sept. 8.) 1200 w.

Serials.

11560. Electric Motive Power. Ill. Albion T. Snell (El–Began March 17, 1893—19 parts to date—30 cts. each).

21777. Cost of Electrical Energy (El–Began April 27—Ended Aug. 3—5 parts—30 cts. each).

23866. Dynamo Electric Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W–Began July 21—6 parts to date—30 cts. each).

24437. Elementary Theory of the Induction Alternating Motor. Ill. Rankin Kennedy (E R L–Began Aug. 10—1 part to date—30 cts).

24508. Magnetic Leakage in Dynamo-Electric Machinery. Alfred E. Wiener (E E N Y–Began Aug. 22—2 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A–Began Aug. 25—3 parts to date—15 cts. each).

Telephony and Telegraphy.

24357. Improvements in Telephones. Ill. (Sc A–Aug. 18.) 400 w.

24554. The Attempt to Extend the Telephone Monopoly (W E–Aug. 25.) 5000 w.

*24564. The Telegraph and the War in the East. J. Morris (El–Aug. 17.) 1100 w.

*24566. Signalling Through Space. W. H. Preece (El–Aug. 17.) 3000 w.

24629. The Evolution of the Telephone Switchboard. Ill. Arthur Vaughan Abbott (E E–Sept.) 7500 w.

†24759. Rubber Insulation for Underground Wires in England.—Views of Manufacturers and Engineers (I R W–Aug. 15.) 4000 w.

24900. Telegraphing Forty-five Years or More Ago. C C. Haskins (W E–Sept. 8.) 3000 w.

*24933. The Pacific Cable (E R L–Aug. 31.) 1700 w.

Serials

23307. The Development of the Electric Telegraph. Stephen Vail (E N Y–Began July 4—Ended Aug. 22—8 parts—15 cts. each).

Miscellany.

*24204. Lightning and Lightning Conductors. Oliver J. Lodge (E Mag–Oct.) 3000 w.

24652. Steam and Electric Cableway for Logging and Canal Boat Towing. Ill. (Sc A–Sept. 1.) 1000 w.

*24257. Electric Welding. Benjamin Alfred Dobson (I C T–Aug. 3.) 3500 w.

*24334. Electrical Storage Batteries. J. Appleton (L H P–July.) 3800 w.

24340. The Storage Battery from the Standpoint of the Purchaser. Townsend Wolcott (P A–Aug. 15.) 2100 w.

*24465. Preparation of Solution for Accumulators. H. M. Sayers (El–Aug. 10.) 1300 w.

24502.—75 cents. The Electrical Purification of Water. Thomas M. Drown (T Q–April.) 1600 w.

24509. The Resonance of Electrical Circuits. William A. Anthony (E E N Y–Aug. 22.) 1300 w.

24524. Specifications for Electrical Subways at Baltimore, Md. (E N–Aug. 23.) 4200 w.

24534. Symbols for Physical Quantities and Abbreviations for Units.—Recommended by the International Electrical Congress of 1893 (E W–Aug. 25.) Table.

*24565. Electric Street Fire Alarms (El–Aug. 17.) 2100 w.

*24585. The Obach Dry Cells (E R L–Aug. 17.) 1500 w.

24641. Recent Observations on Earth Currents. W. Finn (E E N Y–Aug. 29.) 1000 w.

24644. The Equipment for Electrical Engineering Laboratories. D. C. Jackson (E E N Y–Aug. 29.) 3700 w.

24663. Preliminary Experiments for Comparing the Discharge of a Leyden Jar through Different Branches of a Divided Channel. Lord Kelvin and Alexander Galt (E N Y–Aug. 29.) 800 w.

24733. Tesla Effects with Simple Apparatus. Ill. H. M. Martin and W. H. Palmer, Jr. (E W–Sept. 1.) 1000 w.

*24756. Experiments for Improving the Construction of Practical Standards for Electrical Measurements.—Report of the Electrical Standards Committee of the British Association (E E L–Aug. 24.) 6800 w.

*24773. The Recent Accidents Occasioned by High-Tension Currents (E R L–Aug. 24.) 3000 w.

*24775. The Electro-Deposition of Cadmium (E R L–Aug. 24.) 900 w.

*24779. Some Advantages of Alternate Currents. Silvanus P. Thomson, with Editorial (El–Aug. 24.) 6500 w.

*24780. On the Construction of Delicate Galvanometers. Arthur Schuster (El–Aug. 24.) 900 w.

*24781. The Equality of the Velocities of Propagation of Very Short Electric Waves in Free Space and Along Conductors. Ill. M. Dufour (El–Aug. 24.) 600 w.

*24782. On Magnetization Produced by Hertzian Currents.—A Magnetic Dielectric. M. Birkeland (El–Aug. 24.) 900 w.

24837.—$1.25. Electric Transmission of Power and Electric Lighting, from the Point of View of the Mechanical Engineer. Alexander B. W. Kennedy (J A N E–Aug.) 12500 w.

24887.—$1. Some Storage Battery Phenomena. Ill. W. W. Griscom, with Discussion (T A I E E–June and July.) 13500 w.

24888.—$1. Continued Discussion of Paper by Alexander Jay Wurtz on "Discriminating Lightning Arresters, etc." (T A I E E–June and July.) 12000 w.

24901. Storage Battery Litigation.—Judge Green's Decision (W E–Sept. 8.) 2000 w.

24904. How to Deal with Apparent Death from Electric Shock. Ill. Augustine H. Goelet (E W–Sept. 8.) 1800 w.

*24941. Alternate Current Resonance. Ernest Wilson (El–Aug. 31.) 900 w.

Serials.

17546. Recollections of Werner von Siemens (E N Y–Began Nov. 22, 1893—Ended Aug. 22, 1894—12 parts—15 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (E W–Began May 19—15 parts to date—15 cts. each).

23439. On Impulsive Current-Rushes in Inductive Circuits. Alfred Hay (El–Began June 29—Ended Aug. 10—6 parts—30 cts. each).

24090. The Various Methods of Charging the Public for Electricity from a Central Station. Alfred H. Gibbings (E R L–Began July 27—Ended Aug. 10—3 parts—30 cts. each).

24198. Action of a Transformer with a Condenser in Parallel with the Secondary. Ill. Frederick F. Bedell and Albert C. Crehore (E W-Began Aug. 11—3 parts to date—15 cts. each).

24584. The Electro-Chemical Relations of Carbon at High Temperatures. E. E. Brooks (E R L–Began Aug. 17—Ended Aug. 24—2 parts—30 cts. each).

24642. Protection from Lightning (Abstract.) Alexander McAdie (E E N Y–Began Aug. 29—1 part to date—15 cts).

24826. The Rise of Electricity. J. Mount Bleyer (E R N Y–Began Sept. 5—1 part to date—15 cts).

24884. Electricity in the Modern City. Thomas Commerford Martin (J F I–Began Sept.—1 part to date—45 cts).

24942. The Potential and Current Curves of Different Types of Alternators, and Their Influence on the Candle-Power of Alternate-Current Arcs. G. Rössler and W. Wedding El–Began Aug. 31—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY

Present Industrial Problems in the Light of History.

ASKED by the editor of *The Forum* to "deal with the causes of discontent and their true significance; with the possible lines of improvement; with the effect of the factory system; with the existence of class feeling and with danger to liberty—if there is any—in existing combinations of capital in trusts or corporations, or combinations of men in trades unions and other associations, Mr. Edward Atkinson accepts what to most thinking men would appear a very large contract, and writes upon all these topics with his accustomed grasp of thought, and in his usual graceful, vigorous style.

In seeking for causes of discontent he goes back to the feudal system, and traces social changes up to the present age in historical sequence. He finds the secret of England's dominating power in "the very factory system with which we are struggling." He finds the cause of Napoleon's failure to permanently reconstruct the map of Europe, in failure to recognize "the principle that in the great commerce among nations all men serve each other's needs."

He thinks Napoleon "was conquered by the English money power." He pays an eloquent literary tribute to the power of the almighty dollar—well merited, since it can accomplish so much in these latter days not only in buying and transporting food, but in influencing and controlling legislation, and purchasing police protection for law breakers. A dollar can do a good deal nowadays.

Yet there is discontent. There ought to be discontent. There are wrongs affecting this man who earns a dollar a day. There are wrongs for which society as a whole must be held responsible; wrongs due to putting ignorant men in places of power, who tamper with the standard of value; wrongs due to putting selfish men in places of power, who pervert the force of taxation to private ends; wrongs due to those who, by neglect of their political duties, permit cities to be misgoverned and legislators to be suborned. The discontent which does to some extent pervade great masses of people is a reflection of these wrongs, which those who are affected by them know not how to remedy. If men of intelligence fail to recognize the fact that a part of the discontent which now actuates great masses of people is well grounded, then the remedy may be a very rough one, but it will be complete.

The greatest change in the social condition Mr. Atkinson finds in what Carey called the "societary circulation of commodities"; that is to say, distribution of products made possible by enormous increase of facilities for transportation and communication. As the United States is "the only machine-using nation which possess the power of producing food, fuel, and iron in excess of any possible want for generations to come," Mr. Atkinson regards it as certain that "whatever may be the delay or obstruction, this country will become within a very short time the greatest agricultural, manufacturing, ship-building, and commercial country in the world." In the arts including the production of iron and steel, the textile arts, the working of metals, glass, pottery, etc., Mr. Atkinson thinks strikes more likely to occur than in others. "If all this work were done on the individual principle, and the effort were made to give an equal supply to that we now enjoy, there would be no time left for anything else." The benefits therefore, of the factory system are considered plain by Mr. Atkinson. "Evils consist in our long hours of work of a very monotonous kind, to some extent destructive to individualism."

Mr. Atkinson regards with favor all sorts of industrial organization, and attributes labor troubles in the United States to want of organization of labor. He has no fear of trusts, regarding them, with some exceptions, rather as beneficial than otherwise. He thinks that when all English speaking peoples "are united in reciprocity of trade, all the evil powers of the world must go down before us." If we can eradicate from legislation the error "that in commerce what one nation gains, another loses, almost all the evils that can be cured by legislation will vanish."

The Relations of Employer and Workman.

THE masterly address of Hon. Carroll D. Wright, United States Commissioner of the Department of Labor, read at the Eighth Annual Convention of the National Association of Builders recently held at Washington, and printed in the proceedings of the Convention, contains thoughts upon the subject worthy the careful study of all sociologists as well as of those who, not claiming to be sociologists, are yet anxious to arrive at correct views. The *American Architect* has printed the address. The speaker starts out with the fundamental proposition that the interests of labor and capital are not identical. He says:

> There never was a greater fallacy. They cannot be identical any more than the interests of the purchaser and the seller can be identical, except in so far as one accommodates the other. The interest of the seller is to secure as large a profit as possible. There is a relation existing between the two, but the relation is reciprocal; it is not identical for both parties. Being reciprocal what does it involve?

He next discusses the subject of harmony in the labor question:

> It is only men who create and make uniform things. You can cast a million bullets without being able to discover the slightest difference between them. You can make a thousand pairs or a million pairs of shoes exactly alike. You can produce millions of tons of iron or steel with no difference except such as chemical analysis may show; but the Creator has made variety the rule in all His works.
>
> Now this means much in the labor question, and it involves what I like to call the psychology of it, which means that men's minds differ as much as their views, and that in order to bring any harmony into the labor question you must be able to recognize the difference in the other man's mind. While units differ, interests differ also, and this leads every association which cares anything for the elevation of its own character and every body of men which cares anything for its standard of life to understand the means and methods by which the associated units can be brought into harmonious action.

Difference in "the tone and thought of the age" must also be taken into account. "Individualism, until within a generation or so, was the ruling element—the ruling philosophy. To-day it is all altruism." Of this spirit of the age and its bearings on the labor question the following forcible language is employed:

> It is the altruistic spirit as against the individualistic that rules to-day. We cannot get rid of the influence of the tendency if we will; it is utterly impossible to throw yourselves outside of the tendency of the age in which we live. This tendency has brought us from what the political economists call status, to the condition of contract. This is the very greatest element in the development of the labor question from a condition of status, fixed under the influence and the customs of society and of industry, to one of contract, whereby each man is at liberty to make such contract with his fellowman as he chooses.
>
> Now the only difficulty of this relative to the labor question is that the workingman is not always at liberty to make such a contract as he chooses because he is bound by economical conditions out of whose influence he cannot reach. Therefore, the freedom of contract, which is an expression belonging to this age, is one that does not wholly mean exactly what it says. The employer, trained in business practices, independent in his position, must, of necessity, under the present condition of industry, suggest the terms of the contract, and the other man, who seeks to benefit by them, must come to them because he cannot reciprocate by suggesting; if he does, then comes trouble. If the two parties cannot reach the high plane of industry and free contract, then comes the strike, then come the labor difficulties, then come all the wars of industry which we have seen for the past few years, which are as great and terrific almost on one side of the water as on the other.

The whole labor question is regarded as a "psychological one rather more than it is an economical one"; and through a train of thought indicated by this expression the speaker reaches the subject of compulsory arbitration, in the discussion of which he substantially repeats what he said in his Chautauqua address referred to in the preceding review, and shows the utter hollowness of all expectations based upon such a system.

The advocacy of voluntary arbitration,

and of perpetual boards of arbitration not meeting too frequently, with instances of greater or less success in the settlement of labor difficulties through the agency of such boards, completes an address remarkable for its eloquence as well as for its comprehensive grasp of the entire subject.

Arbitration Under Compulsion.

THE social questions involved in the causes of strikes, the wisdom or unwisdom which looks upon them as remedies for real or fancied wrongs, arbitration as a substitute for strikes and a remedy for the disagreements between employers and employés which are the usual excuses for inaugurating them,—these, and all the relations of labor to capital,—to the commonwealth,—to human progress, are "burning questions" and will continue to be so till a happier day shall discover some ameliorating element that will allay existing discontent.

Leading magazines and reviews are actively dealing with, and obtaining contributions to the literature of these topics from the most eminent writers and profound thinkers.

Out of all this thought and discussion must come, in due time, such suggestions of reform in social relations as will afford relief from the embarrassments, perplexities and obstructions to commerce and industry under which the civilized world now labors, and the dangers always inherent in any great change in the industrial status such as the material progress of the age has wrought in the distribution both of labor and of capital.

Six out of eleven of the papers printed in the *Forum* for August were upon sociological subjects. The August number of the *Nineteenth Century* also contained a strong paper entitled "The Labor War of the United States" and the magazine literature for September is running over with discussions of these and kindred topics. This fact is mentioned as indicating the preëminently absorbing interest of these questions at the present time as evidenced by current periodical literature.

The methods of strikes and boycotts originating abroad, have been developed in this country to a point that justifies the appropriateness of the title just quoted from the *Nineteenth Century*. The daily columns of newspapers teem with accounts of strikes, now of so frequent occurrence that scarcely any issue goes to press without some news of this kind. Weekly papers, also, even those devoted to specialities in arts, industry and science, are joining in the debate upon social questions. For instance, here is the *Iron Trade Review* taking up in a leading editorial the subject of "Arbitration Under Compulsion" and handling it in a very able manner.

This proposed remedy for strikes has been regarded by some as not only promising a complete remedy for all industrial troubles, but as a perfectly feasible system, easy to apply and administer,—in fact a sugar-coated specific for the prevention and cure of all social disorders arising from want of assent of either employers or employés to objectionable demands.

It does not seem to be impressed upon the minds of the most ardent advocates of this method, that there may be some disabilities that render the scheme impracticable.

Its advocacy, which just now appears to be pressed forward without due consideration, is, in the view of the writer of the article cited, "inspired by the belief that in the one wage controversy that has attracted public attention of late, compulsory arbitration would have given the advantage to the men."

"It is almost certain that a compulsory arbitration law would be declared unconstitutional on the first attempt to enforce it against unwilling employers or employés; but even viewing it from the broader ground of equity and the requirements of latter-day social conditions that the constitution-makers could not have anticipated, it is unwise and indefensible It is claimed, in answer to some of the fatal objections raised, that the advocates of the system believe in it only up to the point of compelling the parties to come into court, but do not believe in enforcing the court's decision. Of what avail, then, would be such an expenditure of money and such a use of judicial machinery, if the effect is to be purely sentimental? Public opinion can furnish sentiment in plenty, under existing conditions, but it will effect nothing when it opposes the stronger forces that regulate industrial operations. Public sentiment seemed to be with the miners in the strike of a few months ago, but it did not save them from defeat."

In support of these views the editorial makes a strong argument and reinforces it by quotations from utterances of Hon. Carroll D. Wright, U, S. Commissioner of Labor, and ex-Senator George F. Edmunds of Vermont, to show that, even were the system declared constitutional by the higher courts, it would, if adopted, quoting from Commissioner Wright's speech delivered at Chautauqua a few days ago, "force all the industries of the country into trust formation, or the country into a state of socialism."

The whole argument is, in conclusion, summed up in this strong editorial by the following comprehensive paragraph:

> "In brief, the proposition involves state management of private business, on the one hand, and state control of the labor of men's hands, on the other. Any denial of this statement can only be based on the assumption that the arbitrament is to go unenforced,—and that is equivalent to the advocacy of compulsory arbitration as a farce."

The cause of industrial distress lies too deep to be reached by such legislative makeshifts, or by palliatives of any kind whatever; and it is not surprising that those who perceive this should listen with some impatience to the clamors of would-be reformers whose suggestions are about as valuable as that of garrulous old women would be in a case of disease taxing the highest skill of the most accomplished physicians.

Conciliation, Arbitration, and Mediation.

ANOTHER industrial paper, *The Colliery Guardian*, makes room for a long report of the Royal Commission on Labor, prepared by its secretary, in which the systems of Voluntary Conciliation and Arbitration, and that of Legislative Mediation and Arbitration, and their operation and results in the British Colonies, United States, and foreign countries are reviewed. In this document it is contended that the two subjects, Conciliation and Arbitration, must perforce be treated simultaneously, because in the settlement of trade disputes these methods are so frequently "combined in the procedure of a single tribunal or board which has power to pronounce a decision on the failure of the disputants to effect a settlement," yet the radical distinction between these methods is fully recognized, and even emphasized by a quotation from the report of the New South Wales Commission on Strikes:

"When conciliation has failed it is time for arbitration to begin." A further quotation from the same document defines the distinction:

> The function of a conciliation agency is to bring about a voluntary agreement between the parties to a dispute, while the function of an arbitrator is to determine the merits of the case and give a positive decision.

The report regards voluntary conciliation and arbitration as extremely rare, and judges from the experience of the British Colonies, the United States, and European countries that "the success of such methods presupposes both a high state of organization, at least on the side of the employed, and a disposition on the part of the opposed associations to negotiate on friendly terms."

The views expressed of the operation of these methods in the United States will be of most interest to American readers but are too voluminous for transcription. Labor organizations in America are thus spoken of: "The comparative weakness of labor organizations appears to have been an obstacle in the past to the formation of joint committees on the English system."

The Late Railroad Strike and Its Lessons.

THE manner and methods of conducting the great strike of the American Railway Union headed by Mr. Debs, which was perhaps, taken in all its aspects, the most remarkable attempt ever made in this country to coerce capital by obstructing commerce, are severely criticised in an article written by Hon. R. G. Horr for the New York *Weekly Tribune*. The intimidation of men who, induced by their necessities to accept positions vacated by strikers, thus "seeking to obtain an honest living by honest labor," is called by Mr. Horr a "cruel and outrageous practice." Such intimidation was a marked feature of the strike under consideration.

It is also charged by Mr. Horr that "a strike seldom occurs in this or any other country where the strikers quietly withdraw from their labor, go peaceably to their homes, and refrain from interfering with people who are ready and willing to do the work thus abandoned. Notwithstanding Mr. Debs published every morning for public reading a carefully worded statement advising his followers to refrain from violence and to let all their actions conform to the law," Mr. Horr charges that he was at the same time, by secret telegrams and private advice, encouraging, aiding, and abetting the obstruction of trains and the transportation of passengers, freight and the mails. Mr. Horr asserts that Mr. Debs knew that the statements he thus published were "false in every particular." The failure to inaugurate the strike which Mr. Debs announced would take place through the aid of Mr. Sovereign, the head of the Knights of Labor in the United States, and in which it was asserted "1,000,000" people, scattered all over the United States would lay down the implements of industry and would abandon the immense army of production is noticed. The failure of the call of Mr. Sovereign to aid the strike in any important way is attributed to the fact "that even organized labor had refused to join in a useless crusade against law and order."

"The leaders of the strike found themselves face to face with the Government of the United States as well as with the law-abiding people of this entire nation. They failed because they ought to have failed. There was no reason or sense in what they attempted to do. Even if the Pullman Company had been entirely in the wrong in the original controversy that could in no way justify the attempt to cripple business and endanger life throughout the entire nation. The instance does not exist, it will never exist, where the innocent should be punished for the sake of reaching somebody else, whether that somebody else is guilty or not."

With reference to "the power to call out great bodies of men from their accustomed labor and to deprive large numbers of families of their daily support," Mr. Horr maintains that this course "ends in so much suffering, so many heart burnings, and so many antagonisms that it should be exercised with the greatest care and should never be trusted to the decision of any one man." The establishment of the fact that the "people of the United States believe in law and order" and that the "burning of cars, ditching of trains, the destruction of innocent lives, will not be tolerated in this republic is deemed by Mr. Horr "to be worth all it cost" in the great strike, and he regards it as "now well understood that the business of this nation must not be destroyed to gratify the ambitions or whims of an egotistical leader."

A Later Adam.

In the present current discussions upon social reform it would seem that all who can think and write acceptably are seeking to air their views. The universal interest in sociological problems is not only thus evinced, but a great deal of thought flows into byways, nooks, and corners of literature, so to speak, such as the correspondence columns of the daily press, and short criticisms of articles appearing in the technical publications; as, for example, in the Department of Comment and Criticism in this Magazine. This floating discussion, is the truest obtainable reflection of the popular mind. Lord Macaulay found in the files of old newspapers and in ballad literature of the period covered in his History of England a rich mine of material that reflected popular manners, thought, and feeling. A short article written by Mr. Fred Woodrow, and printed in the *Age of Steel*, expresses an idea that is gaining currency in the popular mind.

This is that the monopolist, as well as a kind of selfishness characteristic of the period, and pervading society from top to bottom, are the product of industrial changes that have increased the intensity of the struggle for existence. Mr. Woodrow starts out with the proposition that every "change in our social industrial condition produces its special type of man. The original Adam was a creation; the later gentleman is an evolution."

> The monopolist of to-day with sovereignty, the stuff of which he is made and the spirit that vivifies it have their nativity in the age that produced him. In fact he is as much a product as he is a sinner, the difference between him and the smaller fry being that he carries under one hat what a thousand others have only in the shape of mincemeat. The man is simply a type of a system. To reform this gentleman we must commence by reforming ourselves, and it is just here the cure of some of our industrial and commercial diseases must commence. It is very easy, and in fact is quite the fashion, to raise our voices against the cupidity and despotism of monopolies and corporations and at the same time be ready to seize the biggest egg on the table for our own breakfast, and compel a sick wife to take in washing to pay for own beer. The difference in such a case between a monopolistic monstrosity and ourselves is one of size but not of spirit. He can swallow a Jonah, and we choke at a sprat.

Of the monopolist, called by Mr. Woodrow "the" Later Adam: he writes:

> Of course in this age of so-called equal rights, personal freedom and a considerable amount of paper religion, it is not in fashion to be without some respect for law and humanity. If there is any iron in our souls it must have a velvet skin, and if we are Shylocks in business we must enclose that gentleman in Samaritan cloth. Hence the later Adam. He builds towns, endows libraries and donates to charities, and yet in a business sense his soul would find hotel accommodations in a gooseberry. He loves money and the world loves him because he has got it. He is the god of the crowd, not for what he is but for what he has. We have evolved this type of man in an age where the sinner and the saint are considerably mixed. It is not his money or his power that makes him a wart on the public body. It is the abuse of these things, and blindness to their responsibilities; so the larger the tree the broader its shadow.

MR. ROBERT LEW SEYMOUR in the *Chautauquan* (August) in an article entitled "What Shall be Done with Anarchists?" deprecates hasty and passionate treatment of these disturbers of the public peace. "Russia would bring a Debs up with a round turn. He would be given free transportation to and a life job in the mines at the utmost confines of the Empire," and he thinks that Germany, Austria, England, France, and other European nations would handle such an agitator as Debs "in an exceedingly expeditious manner for half the provocation he has given here." He attributes our toleration of Anarchists to our love for and faith in American institutions as embodied in the Declaration of Independence. He does not, however, think it was the intention of those who formulated the Declaration of Independence "to convey the idea that all men were equal in the sense of being equipped with uniform power, either physical or mental, but that they were equal in so far as all are guaranteed a fair chance to make the best possible use of their respective abilities." On these fundamental propositions he has written a very entertaining article.

ALL those who are somewhat muddled in their views with regard to bimetallism should read the article on "Political Economy and Bimetallists," printed in the *Bankers' Magazine* (August), and which is an extract from a lecture delivered by Professor Nicholson before the British Economic Association last June. The subject is dealt with in a peculiarly pungent manner. The following sentence in the lecture, which was greeted with laughter, is a sample of Mr. Nicholson's style: "Mr. Ruskin tortured his imagination and the English language to express his loathing for what nobody ever was or ever wrote. The economist, to his view, was a one-eyed flat-fish with the side on which there was an eye always in the mud." To Mr. Ruskin's writings about political economy, together with those of Carlyle, written according to Mr. Nicholson "in a severe attack of dyspepsia, physical and mental, and wherein the Scotch philosopher applied the term dismal to the men and the thing, "forgetting or ignorant of the high eulogium passed on Adam Smith by Robert Burns," Mr. Nicholson attributes the attitude of indifference, as compared with an earlier generation which journalists of to-day assume toward economic questions. The object of the lecture he states to be the effort to "impress upon journalists the advantage and the duty of becoming thoroughly familiar with economic methods and principles, apart from the particular problems with which they were called upon to deal."

"THE Policy of Labor" is another strong article discussing the labor movement from an English point of view, printed in the *Contemporary Review* (August), and contributed by Mr. Clem Edwards. It discusses the effect of elementary education and the institution of cheap press with reference to their political fruits. He thinks the social revolution had begun when workmen could read. On these lines the article is carried out to its conclusion, which is that the next few years will witness a great growth of labor representation.

"CHICAGO'S Message to Uncle Sam" and "A Review of the Chicago Strike of '94," the former by Prof. Frank Parsons, and the latter by Walter Blackburn Harte, both in the *Arena* for September, are perhaps the two most radical articles on the labor question that have appeared during the month. They are written in very opposite styles, but are both exceedingly entertaining." They serve to point the remark made in a previous review to the effect that the industrial situation is the theme of paramount interest now presented to the thinking world, and that the questions raised by the situation can never be dismissed from attention till they reach solutions acceptable to the popular mind.

INDEX TO LEADING ARTICLES.

*24202. The Industrial Development of Chile. Ill. Courtenay DeKalb (E Mag-Oct.) 3000 w.

*24208. Evidences of a Revival in Business.—As Reflected in the New York Market (A Series of Interviews.) (E Mag-Oct.) 3000 w.

*24209. Britain and the United States.—The Cost of Living Compared. Andrew Carnegie (E Mag-Oct.) 3000 w.

*24210. Political Economy and Bimetallists (B M-Aug.) 3800 w.

*24211. The Chicago Object-Lesson. Hartley Withers (B M-Aug.) 1300 w.

24285. Arbitration under Compulsion. Editorial (I T R-Aug. 9.) 900 w.

†24372. A Week on a Labor Settlement. John Law (F R-Aug.) 3500 w.

†24373. The Gold Standard. Brooks Adams (F R-Aug.) 10000 w.

†24375. The Labor War in the United States. J. S. Jeans (N C-Aug.) 4200 w.

24390. The Late Railroad Strike and Its Lessons for Workingmen. R. G. Horr, in N. Y. Tribune (B I S-Aug. 15.) 1800 w.

†24406. The Policy of Labor. Clem Edwards (C R-Aug.) 5300 w.

*24428. Conciliation, Arbitration and Mediation in the Colonies, United States and Foreign Countries.—From the Final Report of the Royal Commission on Labor (C G-Aug. 10.) 9200 w.

24471. The Relations of Employer and Workman. Carroll D. Wright (A A-Aug. 18.) 5200 w.

*24522. What Shall Be Done with Anarchists? Robert Lew Seymour (Ch-Sept.) 2000 w.

*24560. Canadian Tariff Changes (B J T-Aug.) 3800 w.

*24561. Tariff Changes and Customs Regulations—Russia, Norway, The Netherlands, Belgium, France, Spain, United States, Mexico, Costa Rica, Labrador, Gambia and Victoria (B T J-Aug.) 5000 w.

*24608. The Lessons of Recent Civil Disorders. T. M. Cooley (F-Sept.) 9000 w.

*24609. Present Industrial Problems in the Light of History. Edward Atkinson (F-Sept.) 5500 w.

*24610. The Profit-Sharing Labor Unions of Antwerp. J. H. Gore (F-Sept.) 2000 w.

*24611. How to Bring Work and Workers Together. Jacob A. Riis (F-Sept.) 3000 w.

*24718. The American Tariff and British Industries. Editorial (I & I-Aug. 24.) 1500 w.

†24790. Chicago's Message to Uncle Sam. Frank Parsons (A-Sept.) 1500 w.

†24791. A Review of the Chicago Strike of '94. Walter Blackburn Harte (A-Sept.) 18000 w.

24793. A Plan to Increase the Circulation of Currency and Make Better the Roads of the Country. Simon Schriver (G R-Sept.) 2200 w.

*24913. The Wealth of the United States. Editorial (E-Aug. 31.) 2000 w.

*24915. The Alien Question. Editorial (E-Aug. 31.) 2000 w.

*24917. The Law of Trade Combinations. Frederick Pollock (C G-Aug. 31.) 4200 w.

*24926. Trades Unions and Strikes. Editorial (I & I-Aug. 31.) 1000 w.

24963. A Later Adam. Fred Woodrow (A S-Sept, 8.) 700 w.

MARINE ENGINEERING

The Marine Boiler of the Future.

PAPERS read before the Institution of Naval Architects at the last three meetings of this body, held respectively at Cardiff, London, and Southampton, together with the discussions elicited by these papers, in the opinion of *The Engineer*, expressed editorially, "supply ample evidence that an important change in marine boiler construction is imminent."

The old Scotch boiler, notwithstanding its wide use, has also many notable defects; and latterly the type of water-tube steam generators has been undergoing a kind of rapid evolution that has brought it to the front. Not only engineers and naval architects, but also shipowners are beginning to regard it with favor. The article finds an analogy in the present status of marine boilers and that of steam-engines twenty-five years ago, when the advantages of compounding engines were under active debate. That debate resulted in the trial of compound engines, but at first, with caution and hesitation, as the water-tube generators are now being tried. Of the period of compound engine introduction, the article quoted says:

> Setting aside such vessels as the *Thetis* and *Propontis*, which worked at fairly high pressures, numerous ships could be named in which pressures of 30 pounds and 35 pounds were used with compound engines and surface condensers. The success attained was such that engineers took heart of grace and ventured to make boilers carrying 60 pounds. No harm followed. These boilers did not blow up or burn out, and they gave the compound engine a chance. Then came thick steel plates and corrugated flues; and so pressures crept up, and the triple-expansion engine was among us almost unawares. Improvement after improvement was made in the engine but the type of boiler remained the same. From first to last the advance was made with difficulty. There were unceasing disputes with the Board of Trade, which very vigorously opposed the effort to carry high pressures in the Scotch, or indeed in any other kind of boiler. When pressures of 160 pounds had been reached a lull ensued, and for about ten years very little has been done in the way of change. Various causes have, nevertheless, been silently at work; among these may be mentioned the extreme lowness of freights, which has rendered economy of fuel imperative. The demand for high speeds; the adoption of forced or assisted draught; the failure of Admiralty boilers; all these things have operated to stimulate invention—and what is more to the purpose, to induce engineers and shipowners to consider inventions however audacious, instead of putting them aside almost without a thought.

That we are now in the midst of a change in marine boiler engineering, and that the engineer or shipowner who maintains that things are good enough for him as they are "will find himself out of the race in a very brief period," is the assertion made in this article, in proof of which, it sets forth undeniable facts.

> It is a quite familiar fact that none of the older class of steamers can be made to pay. We doubt if there is now running any screw steamer, of fair size, with compound engines. Mr. Asplin's engines in Messrs. Leyland's steamers are, it is true, compound; but they are really, if we may say so, triple-expansion engines with the intermediate cylinder suppressed, working with high ratios of expansion and high pressure. Just as the compound engine and 80 pounds steam cannot compete with the triple-expansion engine and 160 pounds steam, so it will be found that these last cannot compete with engines working with 200 pounds steam, generated in boilers differing more or less from the Scotch boiler. This pressure is not in extended use yet, but it will be in a very short time—possibly by the end of the year. The question is, what will the new steam generator be? At the present moment every marine engine building firm of importance throughout the kingdom is either patenting, experimenting with, or building water-tube boilers of some kind. It remains, of course, to be seen which of all these will survive the test of a life at sea. Possibly the

water-tube boiler of the future has yet to be invented or discovered.

Various kinds of water-tube steam generators are next reviewed, and the general advantages of the system are discussed comprehensively. Among these "the saving in weight and space—often of quite as much value as a considerable saving in coal," is used as an answer to the assertion that any enormous augmentation of economical efficiency is not claimed for any of the water-tube boilers in use The conclusion is that the "unmodified Scotch boiler is going out of fashion, and something else is coming in. What that will be remains to be seen."

Taxation of American Shipping.

NOT insignificant among the disabilities under which American shipping interests now labor is the burden of unjust taxation imposed for state and local purposes in different ports. If we wish to "see ourselves as others see us," it is well to read foreign papers and periodicals occasionally. An abuse that is in its nature local, and yet is of such importance as to incite comment in the foreign press, is editorially treated in *Transport*, the article being in the nature of a review of a memorandum report prepared by Mr. Eugene Chamberlain, U. S. Commissioner of Navigation. This document contains statements of fact not familiar to the public outside of marine circles. That the inequalities in this kind of taxation must seriously affect the commerce of different ports will appear from the following abstract from Mr. Chamberlain's report:

Bath, Maine, levies more taxes on its shipping than are paid by the North German Lloyd Company on over $15,000,000 of shipping to Germany. Portland levies more taxes than the Cunard Company paid to Great Britain last year on nearly $9,000,000 of shipping. Portland taxes are greater than those paid even by Gloucester, Mass., or Detroit, Mich., on about $15,000,000. Taxation in Maine appears to be three times heavier than in California, double that of Georgia, and many times greater than in England, France or Germany. Indeed, none of the three great Transatlantic lines could have been operated under the Maine tax laws, as those laws would have levied taxes on them greater than the amount any of those companies paid as dividends last year.

Taxes levied on shipping at Gloucester last year were more than those paid by the North German Lloyd Company on over $15,000,000 shipping to the German government; or those paid by the Cunard Company on over $9,000,000 of shipping to the British government; and the taxation at that port for State and local purposes is double the rate imposed at San Francisco or Savannah, Georgia, on shipping.

Taxation on shipping at Charleston, S. C., is five times heavier than that levied by Great Britain or Germany.

While Alabama exempts from taxes vessels engaged in the foreign trade, taxes on coasting vessels at Mobile last year were double those paid by the Pacific Steam Navigation Company to the British government on over $6,500,000 of vessel property.

Taxes levied on shipping at New Orleans last year were more than the Compagnie Generale Transatlantique paid on $22,000,000 of shipping to the French government; than the two great German lines, the North German Lloyd and the Hamburg-American Line paid on their combined shipping, valued at over $25,000,000; and were three times the taxes paid by the Cunard Co. on over $9,000,000 to the British government.

San Francisco levied last year $85,675 taxes a sum within $600 of the combined taxes paid by the Cunard Line, the Hamburg-American Line, the North German Lloyd and the Compagnie Generale Transatlantique to their respective governments, on their combined shipping accommodation, upwards of 700,000 tons of the best steel and iron steamships in the world, valued at upwards of $58,000,000.

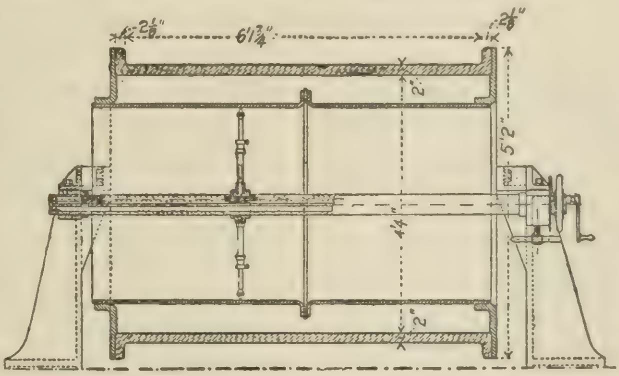
Taxes on shipping for State and local purposes at Detroit were in amount virtually what the North German Lloyd paid on over $15,000,000 of shipping to the German government, and more than the Cunard or the Hamburg-American Lines to their respective governments on over $9,000,000 each.

Milwaukee levied taxes on shipping greater than those paid by the Cunard Company to the British government on over $9,000,000 of shipping.

Taxes levied on shipping at Cleveland, Ohio, last year, were more than the combined taxes paid to the German, French, and English governments by their three great steamship lines, the North German Lloyd, the Compagnie Generale Transatlantique, and the Cunard Line on their $48,000,000 of shipping.

The "evil preëminence of the State of Maine in respect of these dues" is noted. The article then quotes from the *Maritime Register* some remarks upon a species of illegitimate taxation existing in the port of New York, much of which has been recently exposed by the recent investigations of a commission appointed by the New York State legislature.

That a ship coming to a port like New York should, in addition to the rent of a pier, have to pay a harbor master, or a dock master, whose salary is paid by the city, a fee for permitting the vessel to have a berth at all, should pay the customs inspector for performing his official duties, for which he is paid by the Government, should give the police officer a gratuity for doing his duty, would seem to form a system of plunder impossible in any great seaport. Yet it has existed in New York for years and has helped to make this port one of the most expensive in the world. In each case and with each vessel the amount in the aggregate may not seem large. Fifty dollars would cover it in many cases no doubt, but we have known these robberies to have reached three times that amount. The amount, however, is not the only consideration. That such extortions should exist at all is a disgrace and the hurt of New York. There is no reason whatever why they should be paid, and it speaks but illy for our abilities properly to conduct the business of the port that such bribes and blackmail are not wholly prevented.



APPARATUS FOR TESTING STRENGTH OF FURNACES.

It is fair to say with reference to the extortions spoken of in the last paragraph, that since their exposure they have largely ceased, at least as regards those imposed by the police.

Tests of Resistance of Boiler Furnaces to External Pressure.

THE results of a series of tests carried out by the German naval authorities during the years 1887 to 1892, with a view to obtain data relating to the strength of furnaces of internally fired boilers have been put in tabular form and will henceforth become standard. These tests were made at the imperial navy yard at Dantzic, and having been described in the *Zeitschrift des Vereines Deutscher Ingenieure* by Prof. C. Bach, the *Engineering News* has printed a translation, which, together with an inset illustrating the text, places these data at the disposal of those who cannot read the German language. The engraving here reproduced will give a good idea of the apparatus employed in making the tests.

The testing apparatus consisted of a cylinder of forged steel, 52 inches in diameter, 6 feet 6 inches long and 2 inches thick, with end flanges to which ring flanges were bolted, a tight joint being made with red lead. The furnaces to be tested were riveted to these ring flanges, as shown on our inset sheet. The annular space between the tube and the cylinder was connected with hydraulic pressure pumps and two pressure gages were attached. To measure the deformation of the furnace under pressure, a shaft was run centrally through the cylinder, as shown, and a radial extensible arm, carrying a graduated scale, could be revolved by the crank on the shaft and could be traversed upon it by a screw, as shown. The index on the radial arm read to .004 inches. In making the experiments, the hydraulic pressure was increased in increments of about 71 pounds per square inch, until the first deforming of the furnace occurred, accompanied by a sudden fall in pressure. After measuring the deformation, the pressure was again raised until further increase became impossible by excessive leakage through the joints, due to deformation or through cracks in the metal. Between $12,000 and $14,000 was expended on the series of experiments.

Hitherto computations for strength to resist collapsing pressure have been based upon data supplied by the celebrated Fairbairn experiments, whose results were originally printed in the Transactions of the Royal Society of 1858. Of these and the need for additional data *Engineering News* says they "were made with very thin tubes of small diameters. Of 32 tubes tested, 26 had a thickness of 0.043 inch, five of 0.13 inch, and one was 0.25 inch thick. The average diameter was 10 inches.

At present boiler furnaces are made from ¼ to 1 inch thick and 2 feet to 6 feet in diameter. It is somewhat doubtful, therefore, how far the results of the Fairbairn experiments are a safe guide in computing the strength of boiler furnaces at present in use. The tests at the Danzig Navy Yard were made with furnaces of 0.30 inch to 0.60 inch in thickness and 37 inches to 40 inches in diameter. The furnaces tested included 14 plain furnaces, 4 corrugated furnaces, and 1 Purves ribbed furnace. All the furnaces tested were new.

There can be no doubt as to the value of the data thus obtained. Henceforth they will probably be embodied in text books of marine and mechanical engineering, as those obtained by Fairbairn were, and thus become permanently a part of the literature of engineering. For the present, those who wish to use them may obtain them from the article itself, which gives, for plain boilers, the furnace number; material; inside diameter in inches; deformation pressure in pounds per square inch; maximum permanent change of radius in deformed rings in inches, as observed before deformation took place; pressures in pounds per square inch at which the maximum permanent changes of radius in deformed rings occurred; thickness of plates in inches; thicknesses at place of deformation; tests of material; limit of elasticity along fiber in pounds per square inch; the same transverse to fiber; tensile strength, in pounds per square inch transverse to fiber, per cent. of elongation in 8 inches, along fiber, and length of boiler ring in inches.

The Portents of Marine Construction.

THE display of models at the Antwerp Exhibition supplies *Engineering* with materials for an editorial. Under the title given above, this editorial makes a comprehensive examination of the relative merits of screws and paddles for vessels of light draught, such as steamers for navigating the English Channel, etc., and also touches upon the water-tube boiler question without however entering upon its merits. On this head it remarks:

"Very many have formed a conviction; and it will be interesting to notice whether Mr. Howden with his array of facts convinces them, or ultimately recognizes that while his system has proved itself eminently satisfactory for vessels almost of all types, and gives a higher evaporative efficiency for the weight than is got under ordinary conditions, the reawakening of the interests in, and the efficient working of present types of, water-tube boilers, is destined to have an important bearing in the future of all types of high-speed vessels for the question of weight is pressing more and more hardly upon the designer."

With reference to paddles and screws, and the necessity for minimizing draught, it says "it is the limited draught of many harbors, notably those of Europe, which is the chief obstacle to more extensive adoption of the screw." With reference to the modern tendency to substitute twin screws for paddle wheels an interesting statement of speeds at which screws have been run is given in the following excerpt:

"The reduction of the diameter to suit the low draught involves a high revolving speed, but this only demands careful design and workmanship. The three Channel Island vessels of the London & Southwestern Railway Company, the *Frederica*, *Stella*, and *Lydia*—for instance, have engines running at a piston speed of 935 feet per minute, making 170 revolutions per minute, and these vessels run both in season and out of season, and without giving any trouble, so that, as we have said, it is but a matter of design and careful workmanship. And here it may be noted that while the piston speed is high—that of the *Daring* at 29½ knots was 946 feet per minute—the number of revolutions may be increased in the future, enabling a smaller propeller to be used. Still the limit in this respect is not distant. . . . . The necessity for minimizing draught, as we have said is predominant. The Newhaven to Dieppe harbors limit the draught to about 8 feet 6 inches, in few channel harbors can it be allowed to exceed 10 feet at low water, and the naval architect has reason on his side when he urges that this in itself is a limitation to speed. Indeed, it has been said by an experienced naval architect that nearly all our Atlantic steamers might have been a knot or two faster if the draught in their case had not been limited to 28 feet."

An advantage of paddle steamers, besides limitation of draught, is mentioned as consisting in the great expanse of promenade possible, which, with a short two or three hours voyage in fine weather, is an attraction. For this reason it is thought the paddle steamer will continue popular, although for channel service it is likely to be gradually superseded by the twin screw vessel.

AN interesting description of Commodore Barron's prow ship is given in the *Scientific American* of Aug. 18. A model of this queer ship was exhibited in the rotunda of the Capitol at Washington in 1836, and is now preserved in the Seamanship building at the Naval Academy, Annapolis, Maryland. The ship was proposed to be composed of solid logs; to be about 230 feet long and 80 feet in width, and was to float on account of the lighter specific gravity of the timber, 6 to 8 feet above the water. It was to have an iron prow, the whole structure being bolted together in the strongest possible manner. The object of the vessel was to destroy men-of-war by ramming them with the iron prow or beak, and doubtless, a blow struck by this enormous mass, going under steam at full speed, would have been a death-blow to most ships of its period. It is evident from the description that Commodore Barron had a good conception of the principles that have since been embodied in the iron beaks of warships, and that had his vessel ever been built, it would have performed nearly everything the inventor claimed for it. It is asserted that this is the first steam ram ever proposed. It is well to preserve such mementos.

INDEX TO LEADING ARTICLES.

24270. Our Naval Flag Room (B J C–Aug. 11.) 1500 w.

*24296. The Cockerill Company's Shipbuilding Yard at Hoboken, near Antwerp. Ill. (M E–Aug.) 1800 w.

*24300. Recent Experience with Cylindrical Boilers and the "Ellis and Eaves" Suction Draught. F. Gross (P Eng–Aug. 3.) 1800 w.

*24310. How to Make the Ship Canal a Commercial Success.—A Question of National Importance. B. J. Belisha (R P L–Aug.) 2000 w.

*24313. Auxiliary Machinery of a Modern Cruiser. Frederick Arsenius (S L–Aug.) 2300 w.

24359. Commodore Barron's Prow Ship. (Abstract.) George H. Preble (Sc A–Aug. 18.) 1600 w.

24385. Tests of the Resistance of Boiler Furnaces to External Pressure. Ill. (E N–Aug. 16.) 1200 w.

24391. A Serious State of Affairs.—Want of a Large Dry Dock. Editorial (Am S–Aug. 16.) 1000 w.

24414. The Solarometer. Ill. (E M J–Aug. 18.) 1200 w.

*24419. The Portents of Marine Construction. Editorial (E–Aug. 10.) 2700 w.

*24423. The Marine Boiler of the Future. Editorial (Eng L–Aug. 10.) 1800 w.

*24458. Taxation on American Shipping (Tr–Aug. 10.) 1300 w.

24518. Cairo as a Seaport (Sc A S–Aug. 25.) 1100 w.

*24617. The West India Dock (Tr–Aug. 17.) 1600 w.

24646. The Cost of the New Navy (Sc A S–Sept. 1.) 300 w.

*24661. The Ports and Harbors of Great Britain.—Cardiff. Ill. (E Rev–Aug. 20.) 2200 w.

*24697. The Boiler Question in the Navy. Argus (E–Aug. 24.) 4400 w.

24833.—$1.25. Review and Experimental Test of the Steam Plant of the Steamship Iroquois. W. C. Selden (J A N E–Aug.) 5000 w.

24834.—$1.25. The Qualities and Performances of Recent First Class Battleships. W. H. White (J A N E–Aug.) 5500 w.

24835.—$1.25. Albatross. Chief Engineer Isherwood (J A N E–Aug.) 5000 w.

24838.—$1.25. The French Torpedo-Boat "Chevalier." (J A N E–Aug.) 1400 w.

24839.—$1.25. Trial Data of Steamship. J. M. Lincoln (J A N E–Aug.) Table.

Serials.

16636. Marine Engine Design (M W–Began Oct. 6, 1893—13 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E–Began April 14—15 parts to date—45 cts. each).

23761. The Vibrations of Steamships. John H. Macalplne and H. C. Flood (E–Began July 13—Ended Aug. 10—3 parts—30 cts. each).

24263. The Design of Mail Steamers, with Special Reference to Their Use for War Purposes. J. H. Biles (Eng L–Began Aug. 3—Ended Aug. 17—3 parts—30 cts. each).

24365. The Kutubdia Lighthouse. J. H. T. (I E–Began July 14—Ended July 21—2 parts—45 cts. each).

24868. American Ships for American Commerce (Sea-Began Sept. 6—1 part to date—15 cts).

24695. The Guns and their Mountings of Spanish Belted Cruisers. Ill. (E–Began Aug. 24—1 part to date—30 cts).

MECHANICAL ENGINEERING

The Gas Engine in France.

THE best practice in the construction and management of gas engines is discussed in the *Boston Journal of Commerce*, in an abstract from a French report which appears to entertain the belief that this kind of motor is destined to supersede steam engines for small powers in many places. The increase in the range of power of gas engines which through steady progress has now been reached, with the probability that gas engines developing even greater power will be forthcoming, makes the information thus given timely and important.

The article is an abstract from a report made by a committee of a French technical society appointed to investigate the use of gas engines and report thereon. The report appears to regard the displacement of stationary steam engines by gas engines as "only a question of time."

The machines of 1867 consumed from 95 to 124 cubic feet of gas per horse-power per hour. Now machines are regularly made which use only 17.65 cubic feet, as for example, the 8 horse-power Charon motor with single cylinder. This is a remarkable advance; and along with it the use of gas engines has spread; and, further, the tendency is toward a steady increase in the size of the engines. The four leading gas engine makers in France (Charon, Crossley, Niel and Otto) sold, in 1890, 192 engines of 734 horse-power; in 1891, 344 of 1157; in 1892, 516 of 2099; and in the first five months of 1893, 372 of 1821 horse-power. The displacing of steam engines by gas engines thus appears to be a mere question of time; and gas engines solved the problem of the distribution of power in a very convenient way.

But is the motor itself likely to undergo any fundamental changes? There have not been any such since 1889. The proportion of the total heat of explosion lost incidentally is still practically not less than 80 per cent.; and it seems that when the loss from one cause has been reduced that from another has generally increased. There is a limit to the heat which can be recovered as work; not more than 38 per cent. can, even theoretically, be recovered, as Witz has shown; and this means that we cannot expect ever, even in theory, to run gas motors on less than 13.35 cubic feet per horse-power per hour, as an irreducible minimum. But with these data the temperature of the out-flowing gas is 1353° F.

The question of utilization of this waste heat is then considered and discussed with reference to various types of machines, and attempts to convert more of the heat into available work.

The Present Standing of the Gas Engine.

THE same issue of the *Boston Journal of Commerce*, containing the abstract above reviewed, has also an editorial in which some of the inconveniences and drawbacks in the use of these motors are noted. The great increase in the units of work developed is noted, and three 100-horse gas engines used for electric lighting at a power station for an electric lighting plant in Danbury, Conn., U. S., with success and economy for two years, are cited with reference to the difficulty experienced in starting up gas engines in general, and notably gas engines of large size. The editorial was evidently written in a spirit of skepticism regarding the probability that stationary steam engines are ever to be superseded by gas engines. Mention is made of some 200-horse gas engines, now in regular use. Of these and other large engines, the article proceeds to say:

So far these large installations have mostly been placed on the premises of gas works, to do electric lighting, but their success so far as economy is concerned is claimed to be very pronounced and doubtless will lead many other gas plants to use them, and to introduce them further. The engines are, however, far from being so much of a success in every particular as we believe will be necessary to bring them into general use for large powers, nor their economy so low in comparison with the steam engine as the friends of the gas engine claim. The difficulty of starting the large engines cannot be gainsaid. In a recent description of the plant of the Danbury, Conn., Gas Co., with three 100-horse engines, quite an amount of space is necessary to describe the extensive gear necessary to start and stop the engine, and before this comes into use, the shaft to be driven is first started by means of a steam engine of 15-horse power. This is a drawback at the start, and we do not believe the economy of the plant will actually hold a very satisfactory comparison with a steam plant of similar dimensions. A gas engine of this kind will use at a low calculation 17 cubic feet of gas an hour for each horse power and this is an indicated horse power. As the friction of the engine is considerable, between 30 and 40 per cent., an important item for consideration, by the way, the cost in gas for a useful horse power would be about 22 feet of gas, and would cost in Boston 2.2 cents. A steam engine of similar capacity would produce a horse power readily on 20 pounds of steam, or 2½ pounds of coal, and allowing 20 per cent. for friction would require 3 pounds of coal per horse power per hour. This 3 pounds of coal at $4 per ton would cost but 6/10 of a cent, leaving a very large margin to offset any extra costs that could be figured against the steam engine.

Machine For Testing Lubricating Oils.

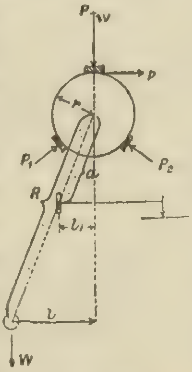


DIAGRAM TESTING OILS.

A "machine specially designed for the use of testing laboratories, manufactories, railways and all users of lubricating oils to whom it is of importance to be able to ascertain in a quick reliable manner the relative antifrictional efficiencies of competing oils" is described in the *Safety Valve*. This machine was designed by Prof. A. Martens, director of the Royal Technical Testing Laboratory at Charlottenburg, Berlin. It is said to be the outcome "of many years' experience in testing oils with a larger machine of the same type designed by Prof. Martens." An illustrated description of the machine in detail is given. The principle of the machine is that of the deflection of a pendulum rod which has a bearing on a revolving journal, to which bearing the lubricant is applied. The amount of the inclination from the perpendicular caused by the friction of the journal upon its bearing is transmitted by a pin and slot connection to a slide carried by rollers and having a scale from which the coefficient of friction can be read off directly. Provision is made for testing the temperatures of the lubricant by means of a thermometer placed in a convenient position for that purpose. A diagram illustrating the principle of the machine is here reproduced. "The extent of throw or oscillation of the pendulum is the direct result of the frictional resistance of the film of oil between the bearing strips and the revolving and testing journal, and is consequently a measure of the coefficient of friction at the observed pressure and temperature."

If r be the radius of the testing journal,
R=distance of center of gravity of pendulum bob from center of testing journal,
a=distance of slide-actuating pin from center of testing journal,
W=weight of pendulum bob,
w=weight of entire pendulum,
$P=P^1+P^2$=pressure exerted by compressor upon the bearing strips, and
x=be the coefficient of friction, then
ρ=the frictional resistance at the circumference of the testing journal$= x\,(P+P^1+P^2+w)=x.\,Q$,
l=throw of pendulum bob,
l^1=throw of slide,

$$\rho\,.\,r=W\,.\,l;\ \text{and}\ l=\frac{R}{a}$$

Then

$$x\,.\,Q\,.\,r=W\frac{R}{a}\cdot l$$

or

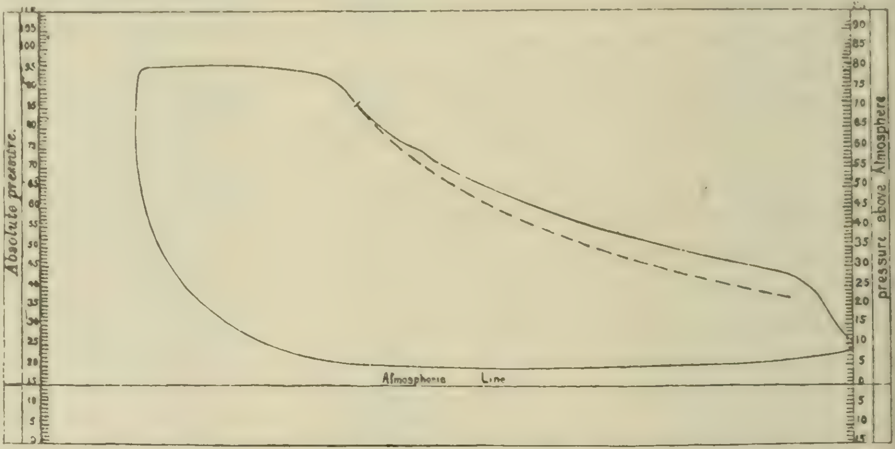
$$x=\frac{W}{r\,.\,a}\cdot\frac{R}{Q}\cdot l^1.$$

These constants having been determined by experiment, the value of x can be recorded automatically by means of a pencil carried by the slide and pressed by a spring against a strip of paper, which is caused to travel at a suitable speed in a vertical direction past the point of the recording pencil, by means of mechanism actuated from the main horizontal shaft of the machine. An accurate and clear idea of the relative antifrictional values of different oils may thus be formed by comparing the curves obtained in testing such oils, with the characteristic curve obtained by testing refined, acid-free, rapeseed oil under the same conditions of pressure and temperature.

Engine Cylinders.

An abstract from the Chief Engineer's report to the Engine, Boiler, and Employers' Liability Insurance Company, Limited, Manchester, England, is printed in the *Mechanical World*. The abstract is made from that part of the report which pertains to steam engines and deals with the design of steam engine cylinders. The examination of such cylinder drawings as have been submitted to the writer's consideration during recent years has led him to believe that he may, without presumption, and perhaps with advantage to steam users, draw attention to a point which, though it materially affects economy of working, seems to be frequently overlooked in cylinder designs.

The point in question is the influence which clearance has upon cylinder condensation. Hitherto clearance has been regarded as injurious rather on account of its waste of steam during the period of exhaust. It is a fact that cylinder condensation is a function of the entire interior surface of steam engine cylinders between the valve inlet and the discharge outlet and that the effect of clearance upon condensation has probably not been appreciated at its full value by designers of steam engines.



INDICATOR DIAGRAM FROM COMPOUND TANDEM ENGINE.

The writer of the report named makes it very clear that condensation, occurring as it does more in the early part of the stroke and during the admission period, must be more largely affected by clearance than has generally been supposed. Especially in steam engines where the cut-off is short, the clearance must be in any case a considerable percentage of the exposed interior surface which, previously cooled during the exhaust period, is again reheated at the expense of the steam during the induction at the beginning of the stroke. It is during this period that the widest difference exists between the temperature of the steam and the interior surface of the cylinder with which it is brought in contact. Consequently the transmission of heat depending upon difference of temperature must be greater during the induction of the steam than in any other equal time in the stroke. More than this, the temperature difference existing at the very beginning of the induction rapidly decreases as the cylinder becomes reheated. The very first portion of the cylinder with which the steam on entering is brought in contact is that of the clearance, which thus becomes the first factor in condensation. From these considerations it is evident that in engines where the total clearance is large, as is the case with many compound, triple, and quadruple expansion engines, the clearance must greatly affect their efficiency.

By way of experimental proof of the truth of this proposition the author cites a case of a compound tandem condensing engine.

The diameters of the cylinders were 12 and 22 inches; the stroke of the pistons 2 feet 6 inches; the speed 80 revolutions per minute. The cylinders were completely jacketed, and the high pressure cylinder had Corliss valves. The boiler pressure was 80 pounds, and the number of expansions varied from 12.9 to 19.2. Surely such an engine should have been economical. Yet the rate of consumption was found on trial to vary from 20 pounds per indicated horse power per hour with steam in the jackets to 21 pounds with the jacket supplies shut off.

The indicator diagrams (one of which, from the high pressure cylinder is here reproduced) suggest the cause. The slow rise of the compression curve, the appearance of late admission (although the valves had nearly 3-16 inch lead), and the full expansion curve, all point to excessive initial condensation, and, in fact, from 51 per cent., or, roughly speaking, one-half of the steam entering the cylinder was condensed during the period of admission. Why was the condensation so excessive? Rather ask, why was the surface exposed to the entering steam so great?

From drawings accompanying the report, it is computed that the volume described by the piston previous to the cut-off is 0.29 cubic feet. The surface required to contain this volume is "a belt of the interior of the cylinder 4.4 inches long and having a diameter of 12 inches." This is the irreducible minimum of surface, 2.72 square feet, the ideal at which the designer of the cylinder should have aimed. The actual amount including clearance is 7.9 square feet of which the clearance surface or the surface exposed to the steam before the piston begins to move at all is no less than 6.75 square feet, or 35.5 square feet of surface to each cubic foot of clearance volume. The report then goes on to point out how this extra surface has been brought in. This part of the report which cannot well be condensed and which is too long for transcription, is a valuable lesson to young draughtsmen in the design of steam engine cylinders.

Power Losses in Transmission Machinery.

AN abstract of a paper read before the American Society of Mechanical Engineers at its recent meeting in Montreal, and printed in the *Safety Valve*, is one of the best contributions to current mechanical literature. The voluminous and useful tables, seven in number, embodied in the paper contain a mass of information which must have caused the author a great deal of labor to prepare, and which, while exceedingly valuable to mechanical engineers in general, must prove especially so to those interested directly or indirectly in power transmission. The main point which the author, Mr. William S. Aldrich (who also prepared the abstract of his paper for the journal quoted), brings out in his able paper, is "that the high speed automatic engine, directly connected (or better, directly coupled) is best adapted to meet sudden and very great variations in electric power plants, while the well-known type of Corliss engine seems best adapted to steady loads." As introductory to such discussion he makes the following statements:

"Cards taken every ten minutes cannot possibly show the real variations of power in an electric railway plant. The frictional losses in the transmission machinery are best determined by special tests, before or after the regular run, having this one object in view.

"In a joint test of an electric railroad, made in 1891, by Hermann S. Hering and the author, they found that it was impossible to arrive at any satisfactory conclusion as to what became of the motive power generated to drive the dynamos, when throwing the load on and off again as quickly as it is done in an electrical railroad. At times there would be as much as 40 horse-power unaccounted for; that is for a few seconds the dynamo output would fall more than 80 horse-power below the then delivered turbine horse-power; while at other times the horse-power delivered by the turbines and the dynamos would be equal. The maximum difference so observed was 140 horse-power, or almost 100 horse-power in excess of that lost in the transmission machinery and dynamo.

"We are greatly surprised to find that the tests of Messrs. Spike and Hugo on the Corliss engines of the Minneapolis and St. Paul electric railway plants do show up much the same as in our tests referred to. They even note that, when lightly loaded, the difference between the engine and dynamo output is minus, showing that the dynamos are delivering more power than the engine, similar to the case we have cited for the turbine plant. We think it is due almost entirely to the fly-wheel action of the transmission machinery. We took the ground that a steam engine ought to be able to regulate itself more quickly and closely than a turbine on account of the elastic nature of the working fluid."

Then follows a most interesting series of diagrams, showing differences between mechanical and electric horse-powers in what is referred to as "Minneapolis test No. 1." Another diagram shows a plot of a variation of losses from turbine shaft to dynamo terminals as determined by a test of the turbine power plant of the "Neversink Mt. Electric Railway," Reading, Pa., under light load, and another of the same plant under heavy load. In each of these tests "marked peculiarities in the variations of the power losses between the turbine and dynamo output are noted." A diagram of curves of power distribution from hydraulic horse-power to car axle horse-power is then given, and the various tables already mentioned follow with summaries of power distribution, efficiency and other valuable data. The topics of power losses in a cable plant and of power losses in transmitting through a countershaft, as shown in special tests made for their determination are also discussed.

Cogging a Mortise Gear.

"A pair of cut steel gears," writes Mr. James F. Hobart, in the *American Machinist*, "well designed and made, will work smoothly and almost noiselessly together, and theoretically indicate perfection in mechanical movement; but in right-down hard every-day practice, a cut pinion, working into a cut mortise gear filled with wooden cogs, leaves nothing to be desired." Mr. Hobart, who always writes ably upon mechanical subjects, goes on to say that "such perfection is seldom met with in mortise gears, or in their pinions. However, if the pinion is first-class a very close approximation to the cut mortise gear is within the reach of every mill man."

By "cut gears" it is understood that the teeth of the gear have either been cut from the solid, or dressed up after casting, by means of a milling cutter in a gear cutting machine. Not only can iron, steel, brass and wooden cogs be dressed in the gear cutting machine, but rawhide cogs would work well; but they are expensive, and when it is decided to use rawhide and metal, for the cogs of a pair of gears, it is usual to cast, and perhaps cut, the gear teeth, then make the pinion of rawhide. The smaller piece is then composed of the more expensive material.

The owners of mortise gears usually buy cogs fully machined all ready to drive and key into the gear. This method is a quick and cheap one, and a gear can be fixed up very quick by using it. But a gear thus filled does not always wear well.

The author then proceeds to say that defects do not arise from difficulty in getting good machined cogs, as these are easily obtainable; but they begin to come in through the process of setting cores while molding mortise gears in the foundry. He then, by means of drawings, illustrates defects arising from imperfect setting of cores, and their remedies, advising that only cogs having blank teeth to be finished after their insertion into the gear be used.

Other imperfections come in during the keying of the teeth in the mortises. The remainder of the article deals with this keying and all the subsequent operations necessary to finish the cogs. This part of the article is fully illustrated by drawings, and the entire article is full of sound and valuable information upon an important subject in machine construction.

THE use of typewriting machines has become so well-nigh universal, that anything written about them has the same kind of popular interest as attaches to articles dealing with home life or household affairs. Many will thus be attracted to the article printed in *Machinery* (London). The article gives not a very exhaustive résumé of the history of type-writing machines. So far as this goes, however, it is good both as to its facts and style, but after this introduction the article degenerates into a bald write-up, evidently prepared in the interest of a prominent manufacturing concern. The illustrations (?) printed with the text, are chiefly a picture of the inventor of the machine manufactured by the house so advertised at the reader's expense of time and patience, with store fronts of buildings occupied by them in New York city, and in Europe; in which the business signs over the doors are the most conspicuous, interesting, and instructive features. It seems a pity that good meat should thus be spoiled in the cooking. The history of typewriting machines, the principles of their action, and details of their construction could be made very interesting by a skillful, competent and unbiased writer.

"TESTING Indicator Springs" is the title of an article printed in *The Boston Journal of Commerce*, in which defects of the present methods of testing springs are indicated and other methods suggested. It is believed that hydraulic pressure is not suited to testing indicator springs for the reason that it does not heat the indicator, which, in its normal working as applied to steam cylinders is always heated. Moreover, the leakage is held to prevent the successful handling of the water pressure. Steam is, therefore, considered necessary, but the measurement of the pressure by a steam gage the author believes not to be accurate, because unless steam gages are of better quality than is usual they will probably indicate more error than the springs to be tested. The article is well worthy the consideration of mechanical engineers. The author believes that all pressure should be measured by the mercury column. He gives the cost of the necessary apparatus as being about $15. The height of a mercury column indicating one pound being very nearly two inches, it is seen that pressures can be read by it to one-twentieth of a pound with sufficient accuracy for testing indicator springs. Of course the temperature must be taken into account and allowance made for change of density due to this cause. The entire article is full of information relating to indicators which those who use these instruments ought to possess. The effect upon indications of even slight friction of the pistons of indicators is thought not to materially affect the accuracy of the usual card, but when excessive it may be much misleading.

MR. FRED H. COLVIN has given some wholesome counsel on shop management in *American Machinist* of Aug. 16. He finds it difficult, however, to establish rules that will fit all cases, in this respect sharing an embarrassment experienced by all who have written upon the subject. The question of the proper relation between superintendents and workmen is considered, and the writer takes the indisputable ground that lack of harmony between them is positively costly to proprietors, as well as disagreeable all around. The writer believes that, "in the great majority of cases there is no excuse for the superintendent dealing with any one but his foremen, and when this is done the efficiency of the shop will be at its best if general plans are laid right."

INDEX TO LEADING ARTICLES.

The Machine Shop.

*24201. Modern American Machine Tools. Oberlin Smith (E Mag–Oct.) 3000 w.

24356. Economical Shop Management. Fred H. Colvin (A M–Aug. 16.) 1800 w.

24358. The Evolution of Handicraft. Ill. (Sc A–Aug. 18.) 2200 w.

24395. Machine for Testing Lubricating Oils. Ill. (S V–Aug. 15.) 1000 w.

24397. Power Losses in Transmission Machinery. (Abstract.) William S. Aldrich (S V–Aug. 15.) 1800 w.

24521. Cogging a Mortise Gear. Ill. James F. Hobart (A M–Aug. 23.) 1800 w.

*24549. Modern Typesetting Machinery. Ill. (M–Aug. 15.) 2400 w.

*24550. Typewriting Machines.—Development Traced in Europe and America.—The Yost Machine Illustrated and Described (M–Aug. 15.) 5000 w.

*24628. How to Splice a Wire Rope. Ill. (Mill–Aug.) 450 w.

24669. Intelligence Conveyed by Drawings. B. F. Spalding (A M–Aug. 30.) 3300 w.

24670. Accurate Hole Locating. Ill. Oberlin Smith (A M–Aug. 30.) 1800 w.

†24883. The Evolution of the Workshop. C. John Hexamer (J F I–Sept.) 4800 w.

Steam Engineering.

*24203. Development of the Steam Engine Governor. Ill. Henry G. Conant (E Mag–Oct.) 3000 w.

24269. Testing Indicator Springs (B J C–Aug. 11.) 1800 w.

24290. Some Experiments on the Effect of Water Hammer. R. C. Carpenter (E R–Aug. 11.) 2400 w.

24394. Boiler Insurance Inspection in England. Ill. (S V–Aug. 15.) 1400 w.

24396. The Boiler Inspection Laws of Great Britain (S V–Aug. 15.) 2500 w.

24405. Another Fly Wheel Explosion.—Nashua Manufacturing Company's Mills. Ill. (B J C–Aug. 18.) 2000 w.

24416. The Heating Power of Smoke. R. R. Tatlock (E M J–Aug. 18.) 700 w.

*24446. Some Reminiscences of Steam Locomotion on Common Roads. (Abstract.) Frederick Bramwell (E E L–Aug. 10.) 3000 w.

24520. Mechanical Stoking. W. H. Booth (A M–Aug. 23.) 500 w.

*24537. Engine Cylinders. Ill. (M W–Aug. 17.) 2500 w.

*24572. The Most Economical Temperature for Steam Engine Cylinders; or, Hot v. Cold Walls. Bryan Donkin (C G–Aug. 17.) 1100 w.

24590. Steam Elevators. How Their Direction of Motion is Reversed. Ill. (B J C–Aug. 25.) 600 w.

24592. Boiler Testing. The Measurement of the Water (B J C–Aug. 25.) 1300 w.

*24607. The Hunting of Governed Engines. James Swinburne (E E L–Aug. 17.) 2000 w.

24630. Application of Fuel Oil to Steam Generators. Clayton O. Billow (E E–Sept.) 5500 w.

24631. Boiler Incrustation. C. E. Bonnell (E E–Sept) 700 w.

24632. The Prevention of Smoke. John C. McMynn (E E–Sept.) 300 w.

*24656. The "Wayne" Steam-Engine Indicator. Ill. (M W–Aug. 24.) 1200 w.

24739. Finding Moisture in Steam.—How a Noted English Engineer Does It (B J C–Sept. 1.) 1000 w.

24740. Compression in Steam Engines.—Too High Compression Not Advisable (B J C–Sept. 1.) 900 w.

*24795. The Economical Efficiency of Locomotives as Compared with Stationary and Marine Engines (A E R J–Sept.) 5800 w.

24799. Tests of Manning Boilers at New Bedford, Mass. (E R–Sept. 1.) 3000 w.

24820. Direct and Indirect Connections to Indicators. Ill. (Pr–Sept.) 1800 w.

24821. The Relation of Steam Space and Horse-Power of Boilers. Stephen Quentin Hayes (Pr–Sept.) 1800 w.

24822. Steam Pipe Covering. Ill. Walter Meyer Dickinson (Pr–Sept.) 900 w.

24858. Steam Power in Mills. W. H. Booth (A M–Sept. 6.) 1500 w.

†24882. The Graphics of the Efficiencies of the Steam Boiler. R. H. Thurston (J F I–Sept.) 2700 w.

Serials.

13033. Practical Hints to Boiler-makers and Templaters. Ill. (M W–Began May 12, 1893—12 parts to date—30 cts. each).

18986. Boiler Calculations. James F. Hobart (S M—Began Jan. 15—Ended Aug. 15—10 parts—15 cts. each).

19709. The Indicator and Its Diagrams. Charles Day (P Eng–Began Feb. 2—16 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E–Began March—7 parts to date—30 cts. each).

21141. High Speed Steam Engines. Ill. John Radinger (E M–Began April—6 parts to date—30 cts. each).

23826. Comparison of Different Formulæ for Dimensions of Parts of Steam Engines. William Kent (A M–Began July 26—3 parts to date—15 cts. each).

24129. The New "Porter" Steam Engine. Ill. (M W–Began July 27—Ended Aug. 3—2 parts—30 cts. each).

24299. The Strength of Thick Cylinders. Ill. W. C. Popplewell (P Eng–Began Aug. 3—Ended Aug. 17—2 parts—30 cts. each).

24722. Methods of Determining the Dryness of Steam—Report of Committee. W. C. Unwin, Secretary (Eng L–Began Aug. 24—2 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L–Began Aug. 31—1 part to date—30 cts).

Miscellany.

*24205. Management of Men in Mills and Factories. W. H. Wakeman (E Mag–Oct.) 3000 w.

*24426. Description of Twin-Screw Propellers with Adjustable Immersion Fitted on Canal Boats. Henry Bancroft (Eng L–Aug. 10.) 2000 w.

24514. Greek Meets Greek.—Locks and Keys. S. W. Streeter (Sc A S–Aug. 25.) 3800 w.

24527. Motor-Driven Carriages for Common Roads. Editorial (E N–Aug. 23) 1800 w.

*24599. The Apprentice System (I C B–Aug. 17.) 1600 w.

*24602. A Warning to Workmen.—Regarding Health (I C B–Aug. 17.) 1500 w.

*24694. The Pneumatic Pyrometer. Ill. Henry Morton (E–Aug. 24.) 2500 w.

*24696. The Critical Side of Mechanical Training. Editorial (E–Aug. 24.) 2800 w.

*24766. The Position of Patent Agents: Collapse of the Bills and Reverses of the Chartered Institute (Inv–Aug. 25.) 3700 w.

*24768. The Decay of Workmanship (I C B–Aug. 24.) 1400 w.

24836.—$1.25. Air Pumps. Ill. F. H Bailey (J A N E–Aug.) 11000 w.

24846. The McMyler Machine for Coaling Lake Steamers. Ill. (Ir Age–Sept. 6.) 1200 w.

24859. Standard Pulley Hubs and Cores. Ill. Walter B. Snow (A M–Sept. 6.) 1600 w.

*24925. The Production of Compressed Air in Paris. Ill. (I & I–Aug. 31.) 1500 w.

Serials.

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M–Began Dec. 7—12 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (El–Began Dec. 1—21 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Albrecht von Ihering (E M–Began Feb.—7 parts to date—30 cts. each).

20171. Practical Notes on Rope-Driving. M. E. (S R J–Began March—4 parts to date—45 cts. each).

20900. Mechanical Drawing. Ill. (T–Began April 1—7 parts to date—15 cts. each).

23937. Some Practical Hints in Dynamo Design. Gilbert Wilkes (S R G–Began July 28—Ended Aug. 25—3 parts—15 cts. each).

24038. Compressed Air.—The Problem of Transmitting Power to Long Distances by Its Use. Ill. (C E–Began Aug.—2 parts to date—30 cts. each).

24173. The German Patent System. Gustav Bissing (E R N Y–Began Aug. 8—Ended Aug. 22—3 parts—15 cts. each).

MINING & METALLURGY

Modern Concentrating Mills.

UNDER existing conditions no branch of metallurgy is of more interest or more pressing importance than that of concentration. This applies more particularly to the mining regions of the western United States, to those of the Spanish-American countries, and to newly opened districts in various parts of the world. In Europe, and especially in Germany, the importance of the subject has long been recognized, and systems of concentration developed to a degree of perfection not attainable where the circumstances are less favorable as to labor and other costs, unless by the substitution of the most advanced mechanical appliances for handwork in certain departments.

A timely series of editorial articles on ore-concentration have lately appeared in the London *Mining Journal*, in which practical applications, rather than mere generalizations, have been considered. The *Journal* records the fact that few mills of the modern type have been erected in the British isles, while German manufacturers have almost a monopoly for work of this sort, and says that it would appear that English and Welsh makers have paid but little attention to the science and art of concentration, having contented themselves with following in the rut beaten out by their predecessors in the early part of the century. It therefore looks for examples of the most perfect forms of modern concentrating mills to those erected by continental firms. Reference might here be made to the very efficient and economical mills of the Lake Superior copper region; but, as the treatment of ores containing but a single mineral (as pyrite carrying gold, galena, copper or zinc) is comparatively simple, the *Journal* devotes attention mainly to the more difficult mixed ores in which the difference in specific gravity between the various valuable minerals and the gangue is so slight as to call forth the utmost skill on the part of the designer of the mill. There are however certain ores containing single minerals—notably the tellurides and chlorides—which on account of a tendency to sliming because of friability and fine dissemination, present problems even more difficult than do the ores of mixed heavy sulphides ; and just now the great demand in the western states is for means of successfully treating this class. However, the general type of mill described by the *Mining Journal* is that adopted in standard practice. Such a mill is usually placed upon a hillside, to take advantage of the natural slope of the ground for the automatic conveyance of the mineral downward from one machine to the next, for which purpose the ground is cut into terraces, on the upper of which the main crushing and hand-picking appliances are placed, on the middle the jigs and fine crushers, and on the lower the slime-dressing machinery. In the opinion of the *Journal* this is by far the most suitable and economical plan. If however the country is flat and the differences of level cannot be obtained except by constructing a high mill, then the only alternative is to use elevators. In mining regions, which are usually mountainous, or at least hilly, sites offering convenient natural grades are generally obtainable, and the common practice has been to take advantage of them, comparatively little grading being required. Yet latterly a difference of opinion as to mill-sites has arisen, and here the *Journal* falls foul of the Denver group of engineers who have abandoned the old system of building a mill in terraces, and prefer to build it on the flat. Their argument is that with improved elevators the cost of maintenance of a flat mill is less than the interest of the money spent in the construction of terraces and that a more compact and convenient arrangement is possible in the flat mill. The *Mining Journal* contends that it is cheaper and handier to allow the stream of crushed ore to run, as a stream of water, down hill through the various machines, than to be constantly elevating it to gain the necessary head. In this it is supported by the best former practice; yet there is much to be said on the other side, while unquestionably the expense of elevating has been so cut down that it is not the bugbear that it has been.

Whichever plan is adopted, the sequence of the machines is the same. Following the *Journal's* description of a typical mill, the ore as it comes from the mine is tipped over grizzlies, and then passes to the rock-breakers. The type of breaker to be employed, as well as the whole system of crushing and classification, it is pointed out, depends upon the size of the mineral grains in the ore, and the *Journal* rightly remarks that the crushing should be conducted with a view to liberating these grains or crystals from the gangue without pulverizing, so as to avoid the formation of slimes as much as possible. This is the recognized principle of successive crushings. From the breaker the ore passes through a coarse sorting trommel, which removes the fine gravel and sand and at the same time washes the large pieces clean for hand-picking. Of the two kinds of hand-picking tables, the longitudinal belt is advocated in preference to the rotating table, as giving more room for the pickers, and consequently a closer sorting. All the ore which has passed through the grizzly, as well as that delivered at the end of the sorting-table, then passes together to the main rolls; which differ from the old form in that they are of larger diameter, revolve quicker, and have rubber buffers instead of weighted levers, as safeties against breakage. The next stage, that of classification by size, is a critical one, and, as the *Journal* observes, here the skill of the specialist is brought into play to determine the number and size of the grades into which the ore is to be divided, the sizes and degree of classification necessarily differing with the variety of mineral treated, its friability, and distribution in the gangue. The question has received much attention at the German metallurgical works, where classification is carried much further than in American mills, many of which crush fine at once, and rely on a single system of concentration. Coarse classification is effected by means of trommels and the fine by hydraulic classifiers. The ore from the trommels goes to the jigs, of which there are one or more for each size produced. These are the standard machines for coarse concentration, although, as the *Mining Journal* remarks, now that they have been improved they are employed fairly within the limits of fine concentration. The product of the jigs is in the form of rich concentrates, middlings and steriles. The first are removed to the bins to await shipment, the last are thrown away, and the middlings are reground by separate rolls. It is to be noted that the old tailings or waste dumps of abandoned works, payable if concentrated with modern appliances, are in the condition of the middlings from the jigs, and from this point their treatment should be similar, starting with the re-crushing machinery.

As the ore becomes finer, the difficulties of concentration increase, and with these difficulties comes increased loss. Since in American gold mills which concentrate after amalgamation the ore is finely crushed (by stamps, not rolls) at the outset, only fine concentration is possible, with its difficulties and losses. Although such mills, equipped with bumping tables and belt vanners, do tolerable work, they are constructed on wrong theoretical lines so far as concentration is concerned; and though the *Mining Journal* does not advert to such cases, its general conclusions are entirely pertinent: "Every effort should in the first place be made to avoid crushing the ore beyond the point at which it will separate from the gangue. If this is not done, and the ore is indiscriminately reduced to powder, the amount of slimes to be concentrated will of course be great, and the loss in concentration equally great. With some ores fine crushing is unavoidable, owing to the mineral being finely dispersed through the gangue. The modern mill manager, however, should so design his mill that the ore is crushed gradually, the rich product being extracted between the crushings, and not, as is too often the case, smashed to powder, and sent on with the slimes to the fine concentrating department." This principle is well understood, but too seldom acted upon, and cannot be too often enunciated.

Pebble Phosphates of Florida.

PEBBLE-PHOSPHATE mining is comparatively a new industry in Florida, having begun so recently as 1890. Mr. Perry M. DeLeon communicates to the *Manufacturers' Record* a comprehensive account of the experience and present condition of the companies operating the pebble deposits, with a description of the mode of occurrence of the latter, from which the following notes are derived. "Land pebble," as its name implies, is a phosphatic pebble varying in size from a pin's head to a hickory nut, most of it being about the size of a pea, although some of it is as large as a walnut; and, as is generally the case, the fine phosphate is higher in grade and freer from iron and alumina. Its color is from a creamy white to a dark brown. It is supposed to occur in drift deposits washed down from the boulder-phosphate region. The average overburden in those mines which have been worked is from four to five feet, but the phosphate is found at varying depths, from an outcrop to many feet underground. The beds are nearly horizontal and vary in thickness from one to twenty feet, averaging about ten feet. Unlike the boulder deposits, the pebble-phosphate beds are continuous over large areas, so that prospecting by sinking pits is simple, and much of the uncertainty of phosphate mining is eliminated. The percentage of clean, washed and dried phosphate to the whole mass of the deposit may be from 20 per cent. to 30 per cent., the phosphate weighing 80 to 90 pounds per cubit foot. The grade varies from 65 per cent. to 70 per cent. of bone phosphate of lime, and the average is stated as fairly 68 per cent. The overburden also varies, consisting of sand or clay in some places and iron conglomerate or sandstone in others.

The land-pebble mines thus far developed are all in Polk county, although excellent deposits are known to exist in the counties to the west and south. The requisites for successful mining are quality, quantity, water and transportation. At present there are ten companies actually mining, three not mining, and two which are erecting plants, while other enterprises are projected. The net commercial results thus far, according to Mr. DeLeon's account, have hardly been satisfactory, large sums having been wasted, and in some cases heavy debts incurred by the companies in the past experimental stage of the industry. This, however, is not considered necessarily discouraging by our authority, who reminds us that all new enterprises have to go through a crucial period, and states that nearly all of the active companies have well-equipped plants and are now mining successfully. The Carolina companies went through a far more trying experience, in some cases occupying five years in solving the problems presented and getting their business on a profitable basis.

Mining is conducted by the hydraulic process, the low, level land being flooded. An hydraulic plant consists of a boat on which are an engine, boiler, force-pump, centrifugal or suction pump, rotary or flat screen, and washer. The force-pump washes the material into a sump, from which it is sucked up by the centrifugal pump and delivered upon the screen, from which it passes to the washer and is discharged into a lighter alongside. The lighter is then poled to the wet bin and the phosphate carried by elevators to the rotary drier and thence again elevated to the dry bin of the mill, where it awaits shipment. This is the usual method. One company uses a dipper dredge, while two companies use steam shovels and convey the material by trams to their washers, and one company employs a grappling dredge; but the pumping method is considered by Mr. DeLeon to be the best, steam shovels being applicable only under exceptional conditions. Early failures are ascribed to inefficient equipment, which defect has been remedied by the introduction of more powerful plant.

Good phosphate land, where the conditions already mentioned are favorable, sells for $50 to $75 per acre; lands remote from transportation cheaper. A plant of machinery costs about $50,000, and in all at least $75,000 to $100,000 is necessary to start a mine capable of producing from 20,000 to 40,000 tons yearly. The plants being put up are designed by experienced experts, and their management will be more economical. The outlook is reported as promising.

The Emery Deposits of Naxos.

NAXOS is remarkable as being one of the few localities producing emery on a large scale, and while the corundum mines of the United States yield an even more valuable product, large quantities of the Naxos mineral are annually imported for use in the various arts. Mr. A. Gobautz has lately presented a monograph on the emery deposits of the island, which appears in the foreign abstracts of the Institution of Civil Engineers and is reprinted in the *Colliery Guardian*. The author describes the deposits as of irregularly bedded or lenticular form, being concentrated on the mountains at the northern end of the island. The masses of emery are very variable in size, ranging in length from a few feet to upwards of 100 yards, with a maximum thickness of from 5 to 50 yards. They are closely associated with limestone beds, and lie at all degrees of slope from horizontal to nearly vertical. Seventeen different deposits have been found and worked. The largest working covers an area of more than 30,000 square meters, extending for more than 500 meters in length with a maximum thickness of 50 meters. The highest quality of mineral is taken from two comparatively thin but extensive deposits, in stratified bands. Mineralogically, emery is a compact mixture of blue corundum and magnetic iron ore, its value increasing with the proportion of the former constituent. The average composition is about ⅔ corundum, ¼ magnetite, ⅛ silica, with some carbonate of lime, while inferior samples have been found to contain as much as 60 per cent. to 66 per cent. alumina. The method of mining is described as extremely primitive. The right to mine is given to about 600 workmen, who have the privilege of working the mineral wherever and in what way they think best. The rock is broken only by fire-setting. An area 5 feet broad by about the same height is cleared from loose material, and a pile of brushwood heaped against it and lighted. After being thus heated for 24 to 30 hours, the rock is suddenly chilled by throwing water upon it, when fractures are produced, enabling the mineral to be broken down and removed. Very rarely blasting with dynamite is resorted to. There are no extensive underground workings, the method of fire-setting being applicable only at the surface. Systematic quarry working, with diamond boring machines and powerful explosives, and the use of wire ropeways and jetties for facilitating transportation, are projected; but the primitive system still obtains. The competition of the emery mines of Asia Minor has become so severe that exports of emery from Naxos have greatly fallen off. It is somewhat remarkable that a foreign company, employing the means of working the deposits by modern methods, has not obtained a concession to utilize these valuable resources on a large scale.

Electricity in Coal-Mining.

FOR some time it has been possible to claim that all the operations of mining in which power is required can be performed by the aid of electricity, added to which the same agency is applicable for lighting the underground workings and the surface plant, for signaling, and for firing the blasts. Complete installations of electric equipment are now no rarities either in American mines or those of other countries, especially where water-power is available, even if at some distance from the point of application, to which the subtle energy is readily conducted, often in positions where, from excessive altitude and the scarcity of fuel or water the use of steam is practically precluded. Such conditions exist at many silver and gold mines of the United States. But there is a far wider field for electricity in mining, and latterly it has been encroaching upon steam and manual labor in regions where a fair competition is offered and comparisons can be made upon even terms. Here the conditions of economy, safety and convenience are fully met by the newly introduced force, whose use is steadily increasing. There are now many mines where electricity is practically the only power employed, for drilling, ventilating, pumping, hauling and winding, signaling, explosive-firing and lighting. As is justly remarked by *Black Diamond*, in a recent editorial article, electricity is, in fact, indissolubly bound up with mining, and especially mining for coal; and no industry has gained more practical benefit from its introduction than the coal industry.

In the article referred to it is pointed out that the old-style lamp and lantern system is archaic as well as dangerous, and that even in the safest collieries a sudden burst of pent-up gas may work irreparable harm. The advantages of the incandescent lamp are that it requires no trimming, is not affected by currents of air and is exposed in no way to contact with gas. The danger of breakage is partly provided against by having double glasses. This lamp throws a far more powerful light, thus expediting work and enabling the miner to detect loose roof or threatening coal falls in thick seams; while the best of the safety lamps give insufficient illumination the stronger arc light is valuable at the pit-head, at the screens, etc. Great improvements have been made in drills, and several electric rotary drills have been used with success. Coal-cutting machines driven by electricity have also been greatly improved, and in operating these and other underground machines sparking is obviated. The electric fan, placed at the most advantageous positions, greatly facilitates ventilation. To meet sudden influxes of water what is wanted is a pump that can be quickly got to work on the spot, which is one of the great merits of the electric pump. In French collieries the telephone is extensively used, while electric bells are employed for signaling in English and other mines. These bells can be operated from the moving cage. The simultaneous firing of blasts by electricity effects a saving of time and reduces the proportion of missed shots, thus eliminating a frequent source of danger. *Black Diamond* affirms that electricity not only renders mining healthier and safer, but really improves to a wonderful degree the productive capacity of a mine, with greater facility in handling the product. Our contemporary is not only very positive as to the undeniable advantages of an electric equipment, but sanguine as to further and rapid progress in this direction.

A Model Steel Plant.

A DETAILED account of the great steel plant of the Ohio Steel Co., now nearing completion at Youngstown, Ohio, appears in the *Iron Trade Review*. This enterprise has been brought about by the movement of the center of iron production westward from Pittsburg, the rapid cheapening of steel and its consequent displacement of iron. An appreciation of the situation by the leading iron producers of the Mahoning valley led to a discussion of the steel works project long before any tangible development of the plans or the personnel of the new organization. As the *Review* observes, a modern steel plant means a vast outlay of capital, and so rapid has been the evolution of economizing equipment that plans that have once been allowed to cool would require no little revision to adapt them to the most advanced practice when they are taken up again. The steel mill itself was designed in the latter part of 1892, work being begun early in 1893. From the time that it took shape on paper there has been a steadily increasing drift in the iron and steel markets to confirm the judgment of its promoters, who are largely interested in the local iron industry. The site includes 200 acres, the Mahoning river, which flows through the tract a few hundred feet from the main building, affording ample water supply. In the arrangement of the buildings and transportation great care has been exercised to secure rapid and economical handling of material, and the laying out of yards has been with a view to the most advantageous extension of the present plant. Indeed everything evinces a broad-gage policy and foresight for the future. A site is provided for the blast furnaces which may sometime be erected by the company; but meanwhile Bessemer pig will be bought in the market. A number of furnaces are located within a mile to a few miles of the steel plant. For an enumeration of the items of the equipment the reader must be referred to the original article (*Iron Trade Review*, August 16), but it may be said that everything is thoroughly up to date. For example, in the main boiler-house, containing four batteries, or eight boilers, each of 250 horse-power, the conveying apparatus and mechanical stokers render the whole so nearly automatic that a man and a boy can fire the whole 2000 horse power outfit. The probable output of the works is a matter that actual practice only will demonstrate, so that estimates are rather premature; but at the start 500 tons will be turned out daily, while there is no question as to increasing this in time to 1000 tons, and there are confident expectations that 1500 tons will be ultimately reached. These figures give some idea of the extent of the plant. Besides billets and slabs, sheet and tin-plate bars will be included in the product of the mill. The manufacture of steel rails is something for the future to develop, but when the times are propitious the rail-mill can readily be added. The supply of pig will call for the output of half a dozen of the average blast furnaces of the vicinity.

Gold and Coal in Victoria.

In the last government report the Minister of Mines for Victoria is again able to report an increase in the output of gold in the colony of 16,670 ounces over the yield for 1892. This report has been ably summarized in the *Mining World*, from which abstract it appears that progressive work is being done in all parts of the colony. Attention has been turned to old gold-fields long neglected and in some cases almost forgotten, where formerly the difficulty of separating the gold from the refractory ores of the base metals proved an insurmountable obstacle that is in part removed by improved metallurgical processes. In addition to this much prospecting is being done, resulting in fresh discoveries being made from time to time. The future outlook for the gold-mining industry of Victoria is regarded as more cheerful than might have been anticipated, judging from the financial depression which has prevailed in Australia as well as in other parts of the world.

The concentration and reduction of auriferous sulphide ores, and the saving of fine gold, are problems which still confront the gold-mines of Victoria, as they have and still do in all gold-mining regions. One division of the government department of mines has been engaged in experimenting along these lines. It might be suggested that much light might be gained by studying and profiting by the experience acquired in the gold mines of the United States and of the Transvaal, where to a certain extent, though by no means wholly satisfactorily, similar problems are being worked out in practice.

The coal industry may be said to rank next in importance to gold-mining in Victoria. The known area of workable coal has been much extended by boring. The actual product is not yet very large, but the reports are highly encouraging. The further development of this industry, it is hoped, will provide work and subsistence for many of the men now unemployed.

Valuation of Mines.

On this much-debated and still far from settled question the *Mining and Scientific Press* has something to say in a late issue. After adverting to the influences which lead investors to enter into mining ventures in out-of-the-way regions where the natural conditions are adverse, rather than to buy mining ground in older localities where climate, resources and facility for obtaining machinery are superior, the *Press* comes to the essential points—the difficulty of establishing a standard of value and of getting seller and buyer to ook upon the transaction in the same light. That journal says:

> Most things for sale are worth what they will bring. It is different with a mining claim. Sometimes it is worth less than the purchase money; oftentimes more. But, in the case of buying and selling mining property, that is a matter that ordinarily must be determined after the transfer is made. A man may pay $10,000 for a piece of mining property that will show itself worth $1,000,000 after he has spent a few thousand additional dollars on it, or it may not be worth the amount annually necessary to expend in order to hold it. . . . The same general site, appearance and showing that made one claim worth a million will not hold good in the one adjoining it.

There is undoubtedly a large element of uncertainty as to the value of undeveloped and partially developed mining ground, and this is especially true of mines of the precious metals; yet our contemporary's statement of the case is rather extreme. A mine that has been carefully examined and thoroughly sampled will show very plainly what is in it so far as the development permits investigation. There is always risk, and on the other hand there are occasional "flukes" of unexpected good luck; yet it is not all blind guesswork.

Again, it is possible to estimate in advance with tolerable accuracy what the cost of equipment and for a certain amount of development will be. The seller is often in the position of holding ground which he is unable to work profitably, from lack of means to put in the necessary plant to operate on a large enough scale, and here the advice of the *Mining Press* to holders, to "think twice before a reasonable offer is refused," is quite pertinent. The only trouble is to get both parties to the transaction to agree as to what is "a reasonable offer."

Steel Manufacture in the South.

AFTER long discussion and considerable experimenting, steel-making in the Southern states remains a vexed question, which is treated by Mr. C. A. Meissner, in a very practical and conservative manner in the *Iron Age.* Mr. Meissner considers that Bessemer steel will probably never be made from exclusively Southern ores, as none of them are true Bessemer ores except those of the Cranberry district, North Carolina; and that it is doubtful whether the concentration and phosphorus-elimination of other Southern ores could be done with sufficient economy. There is a proposition to bring Cuban ore to Mobile or Pensacola, there to meet coke from Birmingham, Alabama, with limestone flux near-by, and to erect a Bessemer steel plant to supply the Southern, Southwestern and Central and Southern American markets. The costs of making steel in this way at a gulf port, and the probable market, are analyzed by Mr. Meissner, who is not very sanguine of success until the Nicaragua canal has been built, to open west-coast markets. Turning to the manufacture of basic steel, the author gives the history and the technical and commercial results of the small plants already built, and states that enough has been done to indicate that the process is perfectly feasible. Past failures are ascribed to want of good technical and economical management and to a too keen desire for experimenting with untried methods. As he tersely puts it, "money can build a plant, yet it cannot run it, unless combined with the highest scientific skill"—and this is especially demanded in the basic process and its modifications. Some very fine steel has been made by the existing plants, whose experience is described in detail, with results of tests and analyses of materials and product. The substitution of dolomite for magnesite as a dephosphorizer is reported to have effected a considerable saving in expenses.

INDEX TO LEADING ARTICLES.

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24346. The Hawdon Slag Machine. Ill. (Ir Age–Aug. 16.) 2000 w.

24347. The New Tariff in the Iron and Metal Trades. Editorial (Ir Age–Aug. 16.) 1600 w.

24348. Our Exports of Metals, Machinery

and Hardware. Editorial (Ir Age–Aug. 16.) 1200 w.

24349. A Comparison of the Old and the New Rates of Duty (Ir Age–Aug. 16.) Table.

24354. Notes on Foundry Management. S. Bolland (A M–Aug. 16.) 2000 w.

†24377. Fire Assay for Lead. Malvern W. Iles (S M Q–July.) 3000 w.

24407. Molding Condensors. Ill. (F D–Aug.) 1200 w.

24413. Consumption of Iron in Japan. T. Wade (E M J–Aug. 18.) 700 w.

*24455. Modern Concentrating Mills. Editorial. (M J–Aug. 11.) 2000 w.

24466. A Modern Steel Plant. Ill.—Ohio Steel Company's Mills, Youngstown, Ohio (I T R–Aug. 16.) 2600 w.

24467. The Metal Schedule-Provisions of the Senate Tariff Bill as Finally Passed (I T R–Aug. 16.) 2500 w.

24504. Steel Manufacture in the South. C. A. Meissner (Ir Age–Aug. 23.) 2000 w.

24516. Alloys. J. T. Hewitt (Sc A S–Aug. 25.) 2200 w.

24538. Scandinavia as a Source of Iron Ore Supply. (Abstract.) Jeremiah Head (E M J–Aug. 25.) 2600 w.

*24557. The Separation of Titanium or Rutile Ore. Walter J. May (Inv–Aug. 18.) 1600 w.

*24571. Disintegrating Iron Ore Prior to Concentration. Walter J. May (C G–Aug. 17.) 1000 w.

24597. Is Metallic Titanium in Bulk Probable? Walter J. May (A M & I W–Aug. 24.) 1000 w.

*24604. The Iron and Steel Industries of Belgium (I C T–Aug. 17.) 2000 w.

*24626. Modern Concentrating Mills. Editorial. (M J–Aug. 18.) 1800 w.

24651. Manufacture of Spiegeleisen. Ill. (Sc A–Sept. 1.) 1000 w.

24664. The Armor Plate Report (Ir Age–Aug. 30.) 2500 w.

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*24721. On the Influence of Aluminum Upon the Carbon in Ferro-Carbon Alloys. T. W. Hogg (Eng L–Aug. 24.) 1600 w.

*24765. The Manufacture of Steel in the Open Hearth. James Alexander Lencauchez, with Discussion (I C T–Aug. 24.) 5000 w.

*24784. Examples of Modern Concentrating Mills (M J–Aug. 25.) 2500 w.

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*24916. The Value per Metallic Unit in Proportion to Cost of Iron Ores. Walter J. May (C G–Aug. 31.) 1000 w.

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*24409. Coal in Victoria (Min W–Aug. 11.) 1100 w.

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*24920. The Part of Coal Dust in Mine Explosions. Editorial (Eng L–Aug. 31.) 2200 w.

*24928. Mining Fallacies. Editorial (M J–Sept. 1.) 1500 w.

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MUNICIPAL ENGINEERING

The Waste of Cities.

It is estimated that at the end of the first quarter of the present century only about 5 per cent. of the population of the United States lived in cities. Now, according to a leading editorial in the *Progressive Age* our intramural population reaches 33 per cent. of the total population. With increase of population has come an increase of the waste constantly going on in our cities. This waste consists largely of fertilizing material flowing out through sewers, which annually amounts to millions of dollars. The editorial, however, does not deal with this waste, but with that pertaining to garbage. The subject is considered with reference to three aspects. The first has relation to the expense of the disposal of such refuse as is usually classed as garbage. The second is the effect upon sanitation of present methods, and the third is the economic question of saving the fertilizing materiais which city garbage contains. With reference to methods now in use, and the sanitary aspect of the subject, the article says:

> From reasonable acquaintance with most of the important cities of the country we fail to remember one that has thus far succeeded in disposing of garbage to the entire satisfaction of its population. Several of the prominent cities it is true have expended large sums of money in laudable attempts to solve the problem, but with few exceptions, the means adopted have not met the expectations of the promoters. Some cities derive a revenue from the sale of offal to farmers, the latter using the product mainly to feed pigs, others having salt water advantages, as New York, carry the refuse out to sea, where it is dumped to await the action of tides and winds in carrying the major portion back to neighboring shores, to the injury and annoyance of adjacent dwellers. Open carts are almost invariably employed in the collection of garbage and ashes, and when one of these carry-alls passes through our streets, Gabriel's trumpet is not needed to herald its approach. These transports are in themselves a direct menace to health. The Massachusetts Board of Health has devoted serious attention to the garbage question during the past few years, and in a recent report issued by that body, it is stated that the Boston offal disposed of to farmers and used for the food of swine shows that over 12 per cent. of the hogs within a radius of thirty miles of that city, and 17 per cent. of those kept at public institutions, were infested with trichinosis. Furthermore, the investigations of this board show that the admixture of city swill with the feed of cows increase the alarming death-rate of bottle-fed infants in the tenement sections of Boston.
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> In Boston, early in 1893, a committee was appointed to consider the question of disposal of garbage. The committee was instructed to investigate first, the destruction of garbage by incineration; second, its disposal by chemical treatment, thereby saving its valuable qualities. Naturally the patent-right owner and the man with a theory came to the fore, and the merits of various devices and systems were enthusiastically presented, after which the committee made a tour over the country, inspecting the methods employed in New York, Chicago, St. Louis and other places. For some reason the original committee could not agree to report upon a definite scheme, whereupon a special committee composed of officials identified with the local city government was empowered to carry on the investigation, and on its report Boston has entered into a contract with a concern for building a reduction form of apparatus, for the construction of a plant equal to the requirements of Boston.

The nature of the process (Merz system, said to be entirely inodorous, and by which all microbes contained in the material treated are destroyed) is the subjecting of the mass in closed digesters to the action of steam under pressure. While the digesters are being charged, the vapors arising from the mass are drawn into pipes and discharged into the furnace under the boiler where they are destroyed by the heat together with any microbes they may contain. The material during treatment is constantly stirred. Escaping odors are condensed in water and discharged through pipes into sewers. Oily matters are melted and are then saved for industrial purposes. The mass when sufficiently treated in the digesters, is subjected to powerful pressure which squeezes out liquid portions. Subsequent drying in special dryers completes the process, results of which will be watched with interest by other cities. The process is claimed to completely rob the material of all offensive or dangerous properties, and the paper quoted expresses the opinion that "while the crematory method finds many supporters the action of the Boston investigators will probably put a quietus on this method."

Garbage Cremation in America.

THOSE who desire to form a correct judgment on the opinion expressed in the previous review by the editor of the *Progressive Age*, should read concurrently a paper written by Messrs. Charles T. Bayless of Louisville, Ky., and Arthur E. Merkel, of New York city, and published in *Engineering News*, wherein an enumeration of methods and appliances for garbage cremation beginning with what the writers incorrectly state to be the first cremator ever used in the United States, and ending with the Engle Crematory at the World's Columbian Exposition at Chicago, is presented, occupying about four pages of the publication named.

The first attempt made to cremate garbage in this country is stated by the authors to have been by use of an apparatus designed and built for the purpose by Lieut. H. T. Reilly, U. S. A. The place was Governor's Island in New York harbor. It was applied to the daily disposal of the garbage of the island, which varied from 10 to 30 cubic feet. Of this apparatus it is said that it is of interest not only from the fact that it was the pioneer of garbage cremation in America, but also because it embodied certain features essential to success in incinerating this kind of material. Its construction and operation are described as follows: It consisted essentially of a chamber 4 × 5 × 3 feet lined with fire-brick. and divided into three spaces by two gratings composed of ¾-inch round iron bars, with 1-inch openings between them, and the necessary doors, grate bars (surface 6 square feet) and ash pit. ·The gratings were for the purpose of supporting the garbage so the heat could get through and dry it, and prevent it from stopping the draft, or putting out the fire.

> Its operation was commenced by making a coal fire, and putting the garbage in on the right side to dry; the next day's garbage was put in on the left side, and the dry garbage then raked over the fire. By placing the garbage on the right and left alternately, dry garbage is supplied and the fire kept burning. There was a 50-feet chimney, and but slight odor came from it. This crematory was self-sustaining, no fuel otherwise than garbage being necessary, and of course was very economical in the cost of running it.

A small garbage crematory was also erected in 1885 in Allegheny City, Pa. Natural gas was the fuel employed. In the same year a crematory was built in Montreal, Canada, which is said to have been a modification of what has been called the "English Destructor." Two years later a similar cremator was erected in Chicago, which after trial proved a failure.

The first Engle cremator was erected in Des Moines, Iowa, in 1886; but the large furnace of this kind at Des Moines was not put in operation till 1887. The same year the Forrestal furnace was built in Milwaukee, Wis. In 1887, the Rider furnace was put in operation in Pittsburgh, Pa. In 1888, the Glasgow plant was adopted in Detroit, and the Merz system was adopted in Buffalo.

In a foot-note the editor of *Engineering News* states that the above enumeration is not complete; and also that the first furnace used was not on Governor's Island as stated, quoting from a paper read by Col. W. F. Morse in 1892, a statement that "for 16 years the United States Government has destroyed the wastes of military posts in a special furnace." The editor also corrects another statement of the authors, that the cremators above enumerated are "the principal ones in operation in this country," stating that when the paper was written there were some others in use, and that "at present, a number of new ones are in process of development, or are actually in use." It is also added to this correction, that "the Simonin system deserves mention as well as the Merz, but neither employs cremation." A description of the Rider furnace at Pittsburgh, Pa., of the Merz system, and of the Engle Crematory at the Columbian Exposition follows, with numerous interesting data, that will well repay the reading of those who wish to inform themselves upon the subject. It may be remarked in concluding this review, that a system for disposal of garbage other than that now in use in the city of New York, is said to have been proposed to the city authorities during the past summer, and to have been favorably regarded.

Incandescent Gas Lighting.

In a paper by Mr. R. S. Galloway of Edinburgh, at the annual meeting of the North British Association of Gas Managers, and printed in the *Journal of Gas Lighting*, the system of what is called incandescent gas-lighting, introduced by Dr. Carl Auer Von Welsbach, it is explained that the point of excellence in this system is the fact that the moment the gas is lighted the light-giving body, or mantle, as it is technically called, "is raised to its highest incandescence and this without any forced pressure or alteration of existing fittings." It will be understood that the light emitted with this system is therefore not directly emitted from the gas, but from this incandescent mantle. The gas flame is converted into a heating, rather than a luminous flame, and this heats the mantle to a temperature at which it affords a powerful and beautiful white light. The system, besides giving a far better light, also consumes less gas for a given amount of illumination than is needed with ordinary gas-burners. This system in its early and imperfect stage of development was first exhibited in New York a number of years ago. With reference to the improvements made in the system, Mr. Galloway says:

> It may be well to disabuse the public mind that this present system of Welsbach incandescent gas lighting which has been more prominently brought before you during the past months, is the same as was introduced some seven years ago. It is the same, and it is not the same. True, the idea is the same—viz., raising a filament to a high temperature, or to incandescence through the agency of a flame from an atmospheric burner. But every part of the lamp (mantle included), as already stated, has been improved, till now the whole is almost perfection. The burner is now made to cause practically complete combustion ; is more ornamental than formerly ; and can be fitted with a regulator, which counteracts any variation of pressure.

Advantages over the incandescent electric lamp are claimed. The present "C" Welsbach mantles are claimed to give from 18 to 20 candle-power per foot of gas consumed per hour; or, to use the words of the author "an incandescent 'C' burner, burning 50 per cent. less gas, gives over three times the light" of a similar sized burner without the Welsbach mantle. An ordinary electric lamp gives 16-candle-power nominally. Therefore, more than three electric lamps would be required to give results of one incandescent 'C' gas-burner." Or, putting this in still another way, "for a given sum of money an ordinary 5-feet per hour gas-jet will give three times the light, and an incandescent gas-burner will give over 12 times the light of an incandescent electric lamp." The points made are summed up as follows:

> (1) The light is practically one-eighth the cost of electric light. (2) It is from one-tenth to one-fifth the cost of other systems of gas lighting. (3) Its hygienic advantages are not obtainable with any other system of gas lighting. (4) It can easily and readily be attached to existing fittings. (5) It is suitable for all inside and outside lighting.

Exactly what the mantles are made of is not named; only the vague statement is vouchsafed that "its principal ingredients are certain minerals occurring in high northern latitudes." Dr. Auer is quoted in this connection as stating with reference to these minerals that "they have to change their form many hundred times before they are obtained in the pure state in which they can find application on the incandescent material." This statement, coming from a scientific man seems rather queer, and appears designed to conceal a secret rather than to impart any real information. The mantles, as prepared, whatever they consist of, are claimed to last through 1200 hours of actual service.

In discussing "The question of Low Priced Gas," Mr. Allen R. Foote takes as his text in *Light, Heat and Power* a quotation from the address of Mr. E. H. Jenkins, President of the Western Gas Association. "I am a firm believer in the policy of selling the best quality of gas at the lowest price consistent with earning a fair dividend on the investment made." Mr. Jenkins having quoted a number of Western cities as recent examples of this policy, and having stated that these examples will be watched with interest by the gas companies of the country, Mr. Foote takes the ground that Mr. Jenkins made a mistake in the selection of some, if not all, of his examples. Mr. Foote considers that low priced gas produced "as the result of a war between gas companies and municipal authorities, or between competing gas companies is not produced in accordance with a sound, philosophical and scientific policy." He thinks that the attempt to furnish low priced gas under these conditions leads to fraud or robbery. At the same time he admits that "low-priced gas, philosophically and scientifically produced, is an acquisition of the first importance to the inhabitants of any municipality. As a moral and economic agent it is second to none known to our civilization. Every decrease in price infinitely widens the use of this agent for the production of light, heat and power." His contention is that in the effort to furnish low-priced gas under the stress of competition, abuses are certain to creep in.

THE same number of this excellent magazine contained an excellent article on "The Relief Holder System in Water Gas Manufacture," written by Mr. F. H. Shelton. It is the purpose of this article to show "that the flow of gas through a works making water gas and using a relief holder is more uniform than the flow through the average coal gas works; that under such circumstances the flow may be made practically absolutely constant, and that for reasons of economy, safety, accuracy and uniformity of product, a relief holder should be invariably used whenever possible in the manufacture of water gas." What is meant by a relief holder is then defined, and its proper function and use are discussed at length.

MR. EDWARD M. HARRIS, writing in the *American Gas Light Journal* for Aug. 27, on "Electric Lighting versus Gas," asserts that there is a "strong feeling of dissatisfaction with and want of confidence in the electric light in Great Britain, not only among its consumers in the chief cities and towns, but through the entire country, whether receiving their current from electric lighting companies or from corporation installations paid for by funds taken from the poor old money chest of the public." He avers that in the latter case taxpayers are revolting against the system, especially those who are non-users of the electric lights. The writer charges against electric lighting systems their cost, inconstancy, detriment to vision, imperfections for display, and danger to property and life. He says these defects are so serious in England, that a large number of people have concluded to "let well enough alone," and continue the use of gas. He adds that the illuminating power of the electric light has been greatly exaggerated.

INDEX TO LEADING ARTICLES.

Gas Supply.

*24219. Presidential Address of James M'Gilchrist (J G L–July 31.) 2800 w.

*24220. The Practical Results of Enriching Gas by the Peebles Process at the Alloa Gas-Works. A. Yuill (J G L–July 31.) 2500 w.

*24221. Further Developments of the Peebles Process. W. Young (J G L–July 31.) 3200 w.

*24222. Incandescent Gas Lighting. R. S. Galloway (J G L–July 31.) 1800 w.

24286. The Andrew Gas Engines. Ill. Herman Poole (A G L J–Aug. 13) 1800 w.

*24301. Construction and Working of Regenerator Settings of Retorts. Ill. W. R. Chester, with Discussion (G W–July 28.) 11000 w.

*24329. The Question of Low-Priced Gas. Allen R. Foote (L H P–July.) 4000 w.

*24330. Some Reasons Why Philadelphia Should Retain and Not Sell Its Gas-Works. William Wallace Goodwin (L H P–July.) 4000 w.

*24331. A Gas Company's Method of Working Tar. Irvin Butterworth (L H P–July.) 600 w.

*24332. The Relief Holder System in Water Gas Manufacture. F. H. Shelton (L H P–July.) 2500 w.

*24333. The Municipal Ownership of Works. Arthur Kitson (L H P–July.) 1900 w.

*24335. Natural Gas. Joseph D. Weeks (L H P–July.) 2500 w.

*24336. Which—High Candle Power or Low? (L H P–July.) 4500 w.

24339. The Industry of Gas in the United States of North America. W. Oechelhaeuser (P A–Aug. 15.) 12500 w.

*24370. Discussion of A. Yuill's Paper on "The Practical Results of Enriching Coal Gas from Oils by the Peebles Process at Alloa Gas-Works." (J G L–Aug. 7.) 5200 w.

*24551. Discussion of William Young's Paper on "Further Developments of the Peebles Process of Enriching Coal Gas from Oils." (J G L–Aug. 14.) 6400 w.

*24552. Discussion of Mr. Galloway's Paper on "Incandescent Gas Lighting" (J G L–Aug. 14.) 2000 w.

24591. Gas Engine in France. What the Best Practice Now Is, with Editorial (B J C–Aug. 25.) 1900 w.

24593. Electric Lighting vs. Gas. Edward M. Harris (A G L J–Aug. 27.) 1400 w.

*24614. On the Manufacture of Fire-Clay Gas Retorts, and the Advantage of Having Standard Sizes. P. Hurll, with Discussion (G W–Aug. 18.) 3000 w.

*24615. A 50-feet Diameter Gasholder. Ill. W. B. Featherstone (G W–Aug. 18.) 4500 w.

*24657. The Prepayment Meter System Growing in Popularity (J G L–Aug. 21.) 2000 w.

*24753. New Evidence as to the Atomic Weight of Carbon. J. A. Wauklyn, with Discussion (G W–Aug. 25.) 1500 w.

*24894. The Lighting of Paris. (Extract.) Henri Maréchal (J G L–Aug. 28.) 2000 w.

Streets and Pavements.

24480. Massachusetts Highways and the State. Editorial (R G–Aug. 17.) 1500 w.

*24840. Theoretical Properties of Asphalts. Dolphus Torrey (P–Sept.) 4200 w.

*24842. Oil Residuum in Asphaltic Paving Compositions. Samuel P. Sadtler and J. Edward Whitfield (P–Sept.) 2200 w.

Sewerage.

24381.—$1.50. A Concrete Sewer on Piles. Ill. Eugene Lentilhon, with Discussion (T C E–June.) 3500 w.

24676. Garbage Cremation in America. Ill. Charles T. Bayless (E N–Aug. 30.) 5800 w.

*24841. Diagrams for the Discharge of Circular Sewers. Ill. John W. Hill (P–Sept.) 600 w.

Water Supply.

24214. A Fountain on Every Corner—Denver, Col. (F W–Aug. 11.) 700 w.

†24224. Water Supply for Indian Towns. C. S. R. Palmer (I E–July 7.) 1100 w.

24387. The Comparative Cost of Mechanical Filters and Sand Filter Beds. Editorial (E N–Aug. 16.) 1300 w.

24388. The Relative Estimated Cost of Mechanical Filters and Sand Filter Beds.—Letters (E N–Aug. 16.) 5600 w.

*24619. Borehole Wells for Town Supply. Henry Davey (E–Aug. 17.) 2200 w.

24678. The Chemical Analysis of Public Water Supplies. Henry Leffmann (E N–Aug. 30.) 2300 w.

24679. Leavitt High-Duty Pumping Engine, Mystic Station, Boston Water-Works. Ill. (E N–Aug. 30.) 900 w.

*24746. Water Supply of Towns—Review of Book by W. K. Burton (A L–Aug. 24.) 3000 w.

24797. Filtration. James B. Rider (E R–Sept. 1.) 3500 w.

*24843. Report of Professor Winchell on the City Water Supply of Minneapolis (A B D–Aug.) 2800 w.

Miscellany.

24337. The Waste of Cities (P A–Aug. 15.) 1400 w.

24824. Public Holdings in Massachusetts (G & F–Sept. 5.) 1300 w.

24857. Public Lighting by Municipal Plants. Horatio A. Foster (E E N Y–Sept. 5.) 5000 w.

Serials.

14839. Water Purification in America. Ill. (E N–Began Aug. 3, 1893—14 parts to date—15 cts. each).

22758. The Chicago Drainage Canal. Ill. (R R–Began June 9—12 parts to date—15 cts. each).

23641. Details of Rural Water Supply (B–Began July 7—8 parts to date—30 cts. each).

24213. The Filter of the Water Supply of the City of Lawrence and Its Results. Hiram F Mills (F W–Began Aug. 11—1 part to date—15 cts).

24218. Fifty Years of Gas Manufacture.—A Retrospect (J G L–Began July 31—Ended Aug. 7—2 parts—30 cts. each).

24258. Manchester Main Drainage Works. (Abstract.) William Thomas Olive (I C T–Began Aug. 3—Ended Aug. 17—3 parts—30 cts. each).

24338. Gas Engines. David Solomons (P A–Began Aug. 15—2 parts to date—15 cts. each).

24751. The Gas Manager Abroad. Thomas Newbigging (G W–Began Aug. 25—2 parts to date—30 cts. each).

RAILROADING

A Year's Railway Progress and Its Lessons.

FROM the English Blue Book recently issued by the commercial and statistical department of the Board of Trade, containing railway returns for the whole Kingdom for the year 1893, *Industries and Iron* has compiled some very interesting figures. It appears from these statistics that the railway mileage in the United Kingdom has increased two and one-half times since 1854, the date at which systematic records were commenced. At the end of 1893 there were 20,646 miles of railway in operation, 9374 miles of which were single and 11,272 miles double track. The increase of mileage during the year was a little over 300 miles. The total authorized capital invested in railways was £1,090,898,780. This amount is stated to be nearly twice the amount of the English national debt. The average cost per mile of English railways is given as £47,047. The paper quoted admits that this is a very high average, and later on in the article hints that "no doubt questions might be asked as to the amount of the total capital actually used in the construction, and how much in compensating landlords and paying lawyers at extravagant rates." In this connection it may be instructive to recall the reasons assigned for high cost of English railways as presented by Mr. William M. Acworth, on page 26, Vol. V, of THE ENGINEERING MAGAZINE. Mr. Acworth assigns, among other good reasons, the pressure of public opinion upon railway companies which compels them to expend large sums in construction as an assurance to the public that the roads will be perfectly safe in their operation. He regards this pressure of public opinion as the most potent influence of all the reasons for expensive construction assigned by him.

The article under review states that 873,177,052 passengers were carried during the year 1893, exclusive of season-ticket holders, or, "to put it more exactly, that number of railway journeys was made by the general public." The gross revenue of the railways for the year was £35,849,449, or 44.46 per cent. of the total receipts. The freight traffic consisted of 207,836,308 tons of minerals and 85,454,493 tons of general merchandise transported over a distance of 141,781,026 miles, yielding a revenue of £40,994,637, or 50.84 per cent. of the entire receipts. Rents and other sources yielded an additional revenue of £3,787,806, thus making the total revenue from all sources £80,631,872. It cost £45.695,119 to earn this revenue, leaving a net revenue of £34,936,773, which amounts to about 3.61 per cent. on the invested capital. The tendency to decreased percentage of profits in railroading is noted. A steady decrease since 1889 has been in progress. The percentage in 1893 was less than in any previous year notwithstanding the mileage exceeds that of any previous year. It is also stated that the working expenses of the year 1893 are the largest recorded. The smallest recorded expenses have been 47 per cent. of the invested capital. This has happened in three different years, to-wit: 1860, 1864 and 1871. It is asserted that since 1871 the expenses have always exceeded 50 per cent. During the year 30,000,000 first-class, 60,000,000 second-class, and 782,000,000 third-class passengers were carried.

> An inspection of the returns indeed shows a tendency not only for the second class travel to disappear but also the first class, and, indeed in the not very distant future it almost looks as if there would be only one class. The third class carriages are now as comfortable in every way on many of the lines as were the first class a few years ago, so that what people pay for is not so much increased comfort as a little more select company, and in these democratic days this distinction will tend to disappear.

The gradually decreasing return on the capital invested in railways is noted. The reasons for this tendency are assigned as "the growing competition, the demands of the public for improved accommodation and more rapid communication, and of the workers for higher wages." It is also stated that the workers are demanding shorter hours, and that "as the result of the railway workers' organizations, the railway companies have been compelled to pay three millions more in wages in 1893 than they paid in 1890."

Railroad Companies and the People of the West.

THE results of legislation upon transportation, both on the part of individual states and of the general government of the United States, are considered in a well written article contributed by Mr. F. J. Goddard to *The Independent*, and reprinted in *The Railroad Gazette.* The spirit of antagonism to railroad companies on the part of the agricultural population of the western states is believed by this writer to be at present much less pronounced than it was a few years ago. Mr. Goddard thinks that the "almost constant public discussions of the railroad problem, so-called, during the past few years have had beneficial results in showing to each side the faults of the other, and that from these discussions a better understanding of the questions involved is being developed.

"The general intent of most of these laws, (enacted for regulating railroad traffic) is to prohibit unjust discrimination as between persons and localities, and to provide reasonable rates of transportation for all." While these ends are considered as right, and desirable for both parties, certain difficulties have arisen, the chief of which are the result of impracticable means to accomplish the end sought.

> The interstate commerce law as it now exists furnishes an illustration of this statement. What the public desired was a law which would provide reasonable rates of transportation and guarantee the public against unjust discrimination as between persons and localities, and this was undoubtedly its intent. And yet some of the sections of this law seem, in practice, to interfere with and prevent the accomplishment of this result.

Sections 4 and 5 of the present law are cited as of this character. Of section 4 the author remarks:

> This would appear to state a sound principle, and yet in practice and by reason of commercial, geographical and economic conditions which surround its operation, its enforcement results in either producing discriminations or destroying competition, neither of which were intended.

Of Section 5, commonly called the "non-pooling clause," he says:

> This section prohibits a legitimate means, which was previously used by the railroad companies, to prevent unjust discrimination and illegitimate competition. By illegitimate competition, I refer to that condition which results in railroad companies transporting persons or property at such rates or fares as will not properly compensate them for the services performed. "The laborer is worthy of his hire," is as true of railroads as it is of mechanics, merchants or ministers; and our laws should seek to regulate all the industries and activities of the people in such a manner as will place them upon a just equality, thus stimulating them to perform their greatest use. This has been called the era of speculation, which considered in its ordinary commercial sense, I interpret to mean the obtaining of valuable consideration without at the same time rendering an equivalent. In this sense it is the curse of the age, and our laws at least should be so framed as to discountenance such operations in every form, whether indulged in by railroad companies, commercial bodies or individuals.

The article concludes with remarks upon the railway legislation of the states, which are regarded as being in general "especially in the west, most liberal," but which on this account "have resulted in causing the construction of thousands of miles of railroad for which there was no legitimate public demand, but which were built solely for speculative purposes."

Mr. Goddard thinks this "foolish waste of money should be regarded as a public burden which it must sooner or later become." He thinks much could be learned by American legislators from a study of the railroad legislation in European countries.

> We have much to learn from the experience of

other countries in railroad legislation, both as to laws concerning their construction as well as those governing their operations. Several, if not all, of the European countries have fully recognized the necessity of providing means whereby railroad rates and fares can be changed only by general consent. They thus secure stability, which is essential to the best interests of every legitimate commercial enterprise.

The laws of European countries also provide against building needless roads for speculative purposes. Government operation of railroads is disapproved, and the writer thinks this scheme is not so popular now as it has been. He thinks it only a question of time when the fourth and fifth sections of the interstate commerce law will be repealed or modified, and hopes the time may soon come "when use will be recognized as the true end of all earthly activities."

A Historical Sketch of Railroading Signalling.

THE *Railroad Gazette* is reprinting in serial form with copious illustrations the lecture delivered by Mr. Arthur H. Johnson before the Lawrence Scientific school, Harvard University, Cambridge, Mass., in May of the present year. As might be expected, the series covers a broad field of invention wherein a vast amount of thought and effort has been wasted, but which has evolved finally the advanced systems of improved signalling devices that characterize modern railway practice, and without which or their equivalents, it would have been impossible to have safely employed train speeds even much less than those now common on all great railways.

> In looking over these old records one is impressed by the number of devices which we recognize in the many signal patents taken out from time to time by inexperienced inventors. It would take a long time to briefly describe the great number of different devices that have been proposed for signalling, but I will not dismiss the subject without mentioning a signal proposed about 1845, which revolved quickly to indicate a clear track, slowly to indicate caution and was stopped to indicate danger or stop. Hand signals for use in starting, stopping, backing, etc., were introduced at an early day and have changed very little in principle as used to-day.

The date of the introduction of detonators or torpedo signals is fixed at about 1841. That the date cannot be named more precisely shows how stealthily important innovations sometimes creep into practice in these days of many innovations. Of fog signalling the author states many attempts have been made during the past fifty years to do fog signalling with "automatic machines, working in conjunction with the fixed signals. No such machine has been widely introduced, owing partly to its being bad in principle to depend upon the action of mechanism which is only called into practical use under exceptional conditions, except when, like fire engines, the machine can have constant supervision. In England, where there is much fog, the trackmen have standing orders to report for duty as fog-signal men in case of fog. Each man has his allotted position at a home or distant signal. He takes a supply of detonators and places two of them on the rail or removes them in accordance with the indications of the fixed signal which he serves."

The author lays down, as one of the first principles in signalling, "that the normal position of all signals must be the danger position; and that "should any part of the mechanism fail, the signal should at once fly to the danger position." The logic of the proposition, apparent to all conversant with the subject, may not be so clear to others, but will become so if they will consider the fact that in the operation of any system which necessitates the use of warning signals to make it reasonably safe, any fault occurring in the signalling apparatus, that renders it wholly or practically inoperative, at once introduces an element of danger, which it is the function of the apparatus to indicate. The entire series comprises reviews of the history, principles, and practice, of signalling. Nearly or quite every kind of signalling apparatus or system of signalling of importance is separately described with illustrations that will make the subject clear even to readers who have not had any previous knowledge of the subject.

A Great Intercontinental Railway.

THE Report of the Intercontinental Railway Commission is now about completed, and *Transport* makes it the theme for an interesting article under the title, "A Great Intercontinental Railway." This journal says the advance sheets indicate that the report "will be a marvelously interesting work from every standpoint. It will give important information concerning railway possibilities never before offered to the world, and will trace a continuous railway route extending from Mexico down to Argentina, a distance of 4500 linear miles. It will fairly bristle with newly ascertained facts and practical statistics touching all the republics of South America; it will be illumined by a profusion of photographs of life and scenery along the whole route, and will be still further enriched by a vast quantity of charts and maps—topographical, geographical, and geological—of the regions traversed, thus combining the features of a fresh book of travel and adventure with the more substantial features of a technical report. But above all, the report will demonstrate the entire feasibility of constructing an intercontinental railway, and will show conclusively that no insurmountable engineering difficulties stand in the way of such a momentous undertaking."

The article goes on to give a history of the commission, which first met and was organized in Washington under the auspices of the State Department in December, 1890. The scope of the work is then stated. The organization of the three different surveying corps of engineers, and the apportionment of their work into divisions is described. Corps No. 1, under Lieutenant M. M. Macomb, U. S. A., commenced work at Ayutla, on the Northern frontier of Guatemala, and a continuous line of survey was run from that point south-east, through the republics of Guatemala, Salvador, Honduras, Nicaragua, and Costa Rica, by way of Retalhulea, and other intervening places to the Rio Savegre.

Corps No. 2, under Engineer W. F. Shunk, of Harrisburg, Pa., started in at Quito and surveyed northward till the party reached the Rio Savegre, thus connecting their work with that of Corps No. 1.

The third corps, under Mr. W. D. Kelly, C. E., of Philadelphia, Pa., also started in at Quito and worked southward to Cuzco. The length of the entire line surveyed was 4234 miles.

INDEX TO LEADING ARTICLES.

*24255. The London, Chatham and Dover Railway Company and Its Continental Services (E–Aug. 3.) 1600 w.

24265. Cleaning of Passenger Cars. A. M. Waitt (R C J–Aug.) 1000 w.

24279. What Is the Use of Car Steps? Editorial (R A–Aug. 10.) 800 w.

24280. The Illinois Central's Suburban Train Service (R A–Aug. 10.) 800 w.

24281. Trial by Jury—Speculative Suits; Extortionate Verdicts Against Corporations. Address of A. J. Ricks (R A–Aug. 10.) 3600 w.

24295. A Great Inter-Continental Railway (Tr–Aug. 3.) 1100 w.

*24297. Glasgow Central Underground Railway. Ill. (R W–Aug.) 4200 w.

*24306. La Guaira and Caracas Railway. E. H. A. Heinke (R P L–Aug.) 1500 w.

*24307. Conversion of Gage on the Bengal-Nagpur Railway. George Moyle (R P L–Aug.) 3300 w.

*24309. A Railway Crisis. G. A. Sekon R P L–Aug.) 2000 w.

*24312. Temperature as Affecting Railway Axles. Thomas Andrews (R P L–Aug.) 2500 w.

24321. Can Interference with the Movement of Commerce Be Prevented? From Harper's Weekly (R R–Aug. 11.) 1500 w.

24323. The Railways of Australia. Daniel W. Maratta (R R–Aug. 11.) 3000 w.

24324. The American Railway Union and Its Methods. Address of J. A. Musterd (R R–Aug. 11.) 2500 w.

24325. Cliff Railways. George Croydon Marks (R R–Aug. 11.) 2000 w.

24326. Legislative Management of Railways. Editorial (R R–Aug. 11.) 800 w

24355. New Air Brake Practice. J. Heon Crosman (A M–Aug. 16.) 700 w.

*24404. Private Ownership of Rolling Stock.—The Fife Judgment (Ry T–Aug. 11.) 1100 w.

We supply copies of these articles. See introductory.

24453. The New Union Station at Boston. Ill. (R A–Aug. 17.) 600 w.

24478. Steel Rails. (Extracts.) P. H. Dudley (R G–Aug. 17.) 3000 w.

24479. The Effect of Valve Travel on Efficiency. Editorial (R G–Aug. 17.) 1400 w.

24491. Railroad Companies and the People of the West. F. J. Goddard in the Independent (R R–Aug. 18.) 1300 w.

24493. Concrete Work on the Calanas-Tharsis Railway, Spain. Ill. Archibald Miles Anderson (R R–Aug. 18.) 1400 w.

24507. A Vast Army (M S P–Aug. 18.) 600 w.

24529. The New Union Station at St. Louis. Ill. (R G–Aug. 24.) 1800 w.

*24568. Railroading in America. Ill. (Eng L–Aug. 17.) 3700 w.

*24582. Character Sketch. Eugene V. Debs: President of the American Railway Union. Ill. (R of R–Aug.) 6500 w.

24586. Railway Companies and Their Employés. Ossian D. Ashley (R A–Aug. 24.) 3800 w.

24587. Sequel of the Strike (R A–Aug. 24.) 1600 w.

24598. Far Away Sweden and Its Railway (B I S–Aug. 25.) 600 w.

*24616. The Opening of the West Highland Railway (Tr–Aug. 17.) 4000 w.

24622. Railroad Traffic Associations. Edward T. Jeffery (R R–Aug. 25.) 1800 w.

24623. "Blacklisting." Editorial (R R–Aug. 25.) 800 w.

*24662. Chinese Railways and Chinese Ironworks. Ill. G. P. Snelus (E Rev–Aug. 20. 1200 w.

*24672. Reminiscences on Locomotive Smoke-Boxes, Exhaust Nozzles and Stacks. Ill. W. H. Thomas (L E–Sept.) 2600 w.

*24673. Broken Stay-Bolts.—Cause and Effect. Ill. Charles E. Fourness (L E–Sept.) 1100 w.

24680. To Prevent Swindling in Railroad Management, with Editorial (R G–Aug. 31.) 3000 w.

24715. Southern Railroads of To-day. D. Allen Willey (M R–Aug. 31.) 2400 w.

*24770. Railway Construction in Japan and China (Tr–Aug. 24.) 1600 w.

*24771. The Bechuanaland Railway (Tr–Aug. 24.) 1100 w.

*24810. High Speed on Railways. W. H. Weston (N C B–Sept.) 1600 w.

*24811. Freight Cars. J. F. Boucher (N C B–Sept.) 1000 w.

24815. The Strike at Pullman. Statements of George M. Pullman and Thomas H. Wickes (R R–Sept. 1.) 10000 w.

24870. The San Ellero-Saltino Rack-Railway, with Telfener Rack. Ill. Julian Edward Caccia (E N–Sept. 6.) 700 w.

24872. The Interstate Commerce Statistician's Sixth Annual Report (E N–Sept. 6.) 1900 w.

24875. Cross Sections of Railway Road Beds. Ill. (E N–Sept. 6.) 2600 w.

24891. Notes on German Railroad Practice.—Train Service. E. M. Herr (R G–Sept. 7.) 1700 w.

24893. Night Schools for Railroad Boys. Editorial (R G–Sept. 7.) 2800 w.

24903. Vanderbilt Railroads South.—What It Means for Southern Advancement (M R–Sept. 7.) 1400 w.

24910. The Relation of the Road Master to Block Signaling and Interlocking (R A–Sept. 7.) 4000 w.

*24912. Early British Locomotives. Ill. (E–Aug. 31.) 1500 w.

Serials.

15496. Railroad Coppersmithing. Ill. (L E–Began Sept., 1893—10 parts to date—30 cts. each).

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M–Began Dec.—9 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M–Began Jan.—7 parts to date—15 cts. each).

21747. Steam Tramway Locomotives. Ill. H. Conradi (R W–Began April—Ended Aug.—5 parts—30 cts. each).

22639. A Master Car Builders' Reminiscences. John Kirby (R C J–Began June—2 parts to date—15 cts. each).

23719. The Early Railway Routes to Scotland. G. A. Sekon (R P L–Began July—2 parts to date—30 cts. each).

23887. The West Highland Railway. Ill. (E–Began July 20—4 parts to date—30 cts. each).

24266. Brakes and Brake Calculations (R C J–Began Aug.—1 part to date—15 cts).

24477. A Historical Sketch of Railroad Signaling. Ill. Arthur H. Johnson (R G–Began Aug. 17—2 parts to date—30 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R–Began Aug. 25—2 parts to date—15 cts. each).

24660. The Compounding of Locomotives. Ill. A. H. Tyler (E Rev–Began Aug. 20—1 part to date—30 cts).

24741. The Relative Efficiency of Air Compressors and Locomotive Air Brake Pumps for Shop Use (R E M–Began Sept.—1 part to date—15 cts).

24809. Car Shop Economy. James F. Hobart (N C B–Began Sept.—1 part to date—30 cts).

24817. Recent Turntable Practice. Ill. (R R–Began Sept. 1—1 part to date—15 cts).

24896. The Conversion of Meter Gauge to Indian Standard (5′6″) Gauge on the Bengal-Nagpur Railway. Ill. G. Moyle (I E–Began Aug. 4—1 part to date—45 cts).

24938. Passenger Train Services in 1894 (Tr–Began Aug. 31—1 part to date—30 cts).

STREET RAILWAYS[*]

The Paris Cable Railway.

THE *Iron and Steel Trades Journal*, in describing the road named in the title, gives an interesting account of its construction and operation. The cost of the road was $240,000. As bearing upon the tricks and manners of slots in cable roads, it is stated that "the interval between the time of the practical completion of the works in November, 1890, and the unrestricted opening for traffic in August, 1891, was partly employed in making experiments with the running of from one to four cars at speeds varying from 3.35 miles per hour to the intended regulation working speed of 6.7 miles per hour, and in carrying out various modifications in the position and design of the various guide pulleys which were erected experimentally in the first instance.

As it might be supposed that an investigation of the methods employed in San Francisco, Chicago and London would have enabled the constructors to meet the difficulties encountered without all this experiment, it is explained that "this line differed from either of the foregoing in so far as that, with the exception of the crossing places, it was a single line and with a very sinuous course, owing to the direction and narrowness of the streets passed through; therefore the arrangement of the guide rollers, or sheaves, was complex, and had to be considerably modified before the final completion.

The following details are given with reference to the narrowness of the slots:

On the second December, 1890, after several days' frost, it was found that at several points the gripper slot which originally was intended to be ⅞ inch wide, had become reduced to ⅝ inch, and, as the frost continued so this narrowing became more general. On investigation, the principal causes of this seemed to have been expansion of the paved portions on each side of the track, this action being transmitted from the track rails to the irons forming the slot, the expansion of the sub-soil, frozen to a great depth, exercising an exceptional thrust upon the cable channel walls, and lastly, the contraction of the iron frames carrying the track rails and slot irons.

The remedy was to increase the slot to a width of 1⅛ inches, easing the ties of the frames connecting the track rails with the slot irons and laying a band of asphalt 1¼ inches to 2 inches in thickness between the track rails and the outer strip of paving on each side, this material forming a cushion which absorbed the effects of expansion of the roadway. The remedy was effective, and no narrowing of the slot of any importance has since taken place. The remainder of the article comprises a complete description of the cable driving machinery and the mechanism which carries the cable.

The Boynton Bicycle Railway.

The *Electrical Review* (London) makes some interesting editorial comments on the Boynton Bicycle Railway in contrast with Behr's suspended bar system, and points of similarity as well as of difference are indicated.

While the Boynton idea is considered as being much on similar lines to that of Behr, it differs in this respect, that while Behr's cars run upon a single rail elevated in the air, the cars being suspended from it, in the Boynton system the train runs upon a rail laid on the ground as in the ordinary way, except that it is a single rail, a guide rail being supported in the air and horizontal wheels acting to steady the car or cars upon the supporting rail at the bottom. It is pointed out that a difficulty comes in with reference to the operation of the system on sharp curves and at high speeds. In discussing this point the writer remarks that although "there is a small Boynton line at Coney Island and another at Bellport, Long Island, this proves nothing more than the possibility of the idea at moderate speeds. But we are not invited to a moderate speed. The suspension idea was for 100 miles an hour. The bicycle train is to go at 150 miles velocity, and it is as such that we must treat it. Probably the overhead guide wheels would make an intolerable rattle, but that is out of the question for the present. The idea is admirable for a straight piece of line, or for those having slight curves permitting so small an inclination from the vertical that it would not be serious; and as an electrically worked railway, this seems to possess peculiarly suitable features."

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[*] Through an oversight two pages of reviews omitted from this department this month.

As regards speeds, it is thought that the road might be mechanically suitable for moderate speeds, but that the structural expense renders it doubtful as a commercial enterprise. "Looked at as an ordinary light railway, the weak point is the expense of the superstructure." In conclusion the question is asked, "Why, if 150 miles an hour is to be attained on the Boynton line, was this speed not secured in America previous to the asking of support from the guileless and gullible Britisher?"

In Long Island there is truly nominal length enough wherein to start and stop a high flyer, but we have really not room enough to do it here, and in all seriousness we must state that, however mechanically pleasing the Boynton idea may be, if considered on sober lines, it is somewhat of an impertinence to put forward half digested schemes of this sort. We are so plainly given to understand that there will be curves, and yet nothing is said as to how passengers fare when the patented inclination does not agree with the curve. Perhaps there will be patented passengers.

INDEX TO LEADING ARTICLES.

*24207. Evolution of the Electric Railway. Irving Hale (E Mag–Oct.) 3000 w.

24267. Electrolytic Corrosion: Legal Status of the Question. R. D. Fisher (S R G–Aug. 11.) 1800 w.

24268. Gas Motors for Street Railways. Frank H. Mason (S R G–Aug. 11.) 1700 w.

24368. The Reno Underground Rapid Transit System. Ill. (E E N Y–Aug. 15.) 900 w.

*24441. The Boynton Bicycle Railroad (E R L–Aug. 10.) 2000 w.

*24481. Electric Power on the Chicago City Railway. Ill. Cable Moved by Electricity (S R R–Aug.) 2300 w.

*24482. Electric Car Heating. Ill. W. S. Hadaway, Jr. (S R R–Aug.) 1200 w.

*24483. The Barmen Electric Rack Railway. Ill. (S R R–Aug.) 800 w.

*24484. Leavenworth's Line. Ill. (S R R–Aug.) 1800 w.

*24485. Ex-President Harrison on the Indianapolis Franchise (S R R–Aug.) 4000 w.

*24487. The Three Wire Trolley System at Bangor, Me. (S R R–Aug.) 800 w.

24488. First Electric Railway in Russia. Ill. (S R G–Aug. 18.) 500 w.

*24577. Motors for Electric Traction Work. Ill. (I & I–Aug. 17.) 2300 w.

*24579. The Douglas and Laxey Electric Tramway. Ill. (I & I–Aug. 17.) 1900 w.

*24603. The Belleville (Paris) Cable Railway. Maurice Widmer (I & S–Aug. 18.) 1500 w.

24638. Lighting of Electric Railway Cars. (E R N Y–Aug. 29.) 700 w.

24681. Frictional Resistance on Cable Roads. (R G–Aug. 31.) 500 w.

†24701. The Use of Storage Batteries in the Trolley Railway Plant at Zurich, Switzerland. Ill. (S R J–Sept.) 2000 w.

†24702. The Manchester (England) Tramways. Ill. (S R J–Sept.) 1500 w.

†24703. The Hoosick Falls Railway. Ill. J. H. Vail (S R J–Sept.) 1600 w.

†24705. Ascertaining the Speed of Trolley Cars. James F. Hobart (S R J–Sept.) 1600 w.

†24706. The Street Railway System of Montreal, Canada. Ill. (S R J–Sept.) 2000 w.

†24707. New Switching Facilities—Chicago City Railway Company. Ill. (S R J–Sept.) 800 w.

24812. Devices for Keeping the Trolley Wheel on the Wire. Ill. (S R G–Sept. 1.) 700 w.

24871. The Use of T-Rails for Street Railway Tracks. Ill. (E. N.–Sept. 6.) 1000 w.

Serials.

21260. Electric Traction. C. H. Wilkinson (E P–Began April—4 parts to date—30 cts. each).

23713. Emergency and Wreck Wagon Systems. Ill. (S R R–Began July—2 parts to date—30 cts. each).

23909. Notes on Electric Tramways in the United States and Canada. H. D. Wilkinson (E E L–Began July 20—Ended Aug. 3—3 parts—30 cts. each).

24308. The Florence and Fiesole Electric Railway. Charles Scheibner (R P L–Began Aug.—1 part to date—30 cts).

24442. Facts and Figures Concerning Some Continental Electric Tramways (E E L–Began Aug. 10—Ended Aug. 24—2 parts—30 cts. each).

24659. An Electric Railway System for London. Ill. J. H. Greathead (E Rev–Began Aug. 20—1 part to date—30 cts).

SCIENTIFIC MISCELLANY

Arctic Temperatures and Explorations.

ONTARIO has an Association of Land Surveyors, which recently held its annual meeting. The proceedings of such an association might seem to laymen as not promising much of general and popular interest; but in this case a proposition was made that will attract attention the world over. This proposition was no less than that the Canadian surveyors would undertake to run a meridian to the North Pole, if the government would authorize such an enterprise; and a committee was thereupon appointed to consider and report upon the subject.

In the *Popular Science Monthly* for September, Mr. Stuart Jenkins has contributed an article dealing with the possibility of such a survey, which contribution is one of the most interesting miscellaneous scientific papers that has appeared for the month.

He says the proposition "is not so wild as it may seem," and thinks "it will prove interesting to the public to show what Canadian surveyors have already done and compare their methods with those of Arctic explorers."

Mr. Jenkins speaks of the surveyors' methods from personal experience, he having been an instrument man with a survey party in the Canadian North-West, of which Mr. G. B. Abrey, D. L. S., was the chief. There were fourteen men in the party, all told, and this party remained "out under canvas" for twelve months,—June 1882–1883. The work necessitated the moving of the camp daily. "Winter commenced on the 1st of November, when snow fell to the depth of two feet and remained." The outfit is described as consisting of "four ten-ounce duck tents, in three of which were small sheet iron box stoves, and in the fourth, the cook's tent, a sheet iron cookstove. In the winter the food was pork, beans, dried apples, and bread, with tea and sugar; to which may be added eight hundred pounds of fresh beef, and the flesh of one elk or wapiti, and one jumping deer. The party shot prairie chickens when possible. Mr. Jenkins describes the clothing of the party:

"For clothing I wore woolen underclothing, such as I now wear in the city of Toronto, a flannel shirt, and, over these caribou breeches with long woolen stockings drawn over them, a chamois leather vest, and a small single breasted tweed coat such as is worn in the city before overcoats become necessary in the fall. My feet were clothed with duffle and moccasins, and my head with a double knitted, Hudson Bay tuque, which can be pulled right down over the ears. A pair of common woolen mitts completed my outfit. At no time during the winter did I wear either overcoat or muffler. Indeed, neither the one nor the other was to be found in the camp. Mr. Abrey's dress was nearly the counterpart of mine, and the men wore woolen clothing altogether. At night Mr. Abrey and I used two pairs of Hudson Bay blankets and two buffalo skins each. The blankets we sewed up into bags and put one buffalo skin beneath and one over us. We slept on folding stretchers which was, of course, not as warm as sleeping on the ground. The men's sleeping outfits consisted of blankets only."

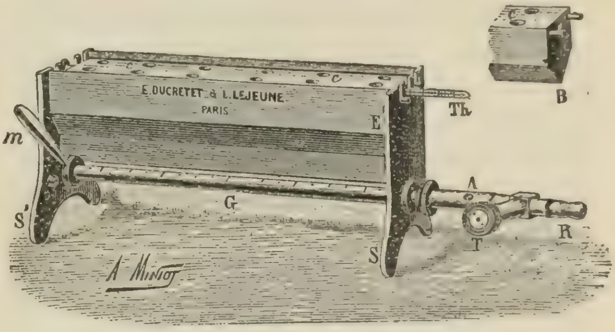
The fuel of the party was dry poplar sticks which Mr. Jenkins states make a good hot fire, but one which cannot be kept more than half an hour without renewal. The party had a standard spirit thermometer which registered down to —62° F. and had been tested by the Toronto observatory. Illustrating the extreme cold to which the party was subjected during the second week in January Mr. Jenkins states that "the cook one morning came bustling in with the breakfast, his shirt sleeves as usual rolled up above his elbows, announcing that the bottom had dropped out of the thermometer." Mr. Jenkins found that in fact the spirit had all run down into the bulb and that therefore the temperature was at some point below —62° F. He says "the news spread through the camp, and the men came crowding round to see the unusual phenomenon. One man ventured the opinion that we had got to the North Pole by mistake, but they looked upon it more as a joke than anything else, and were perfectly satisfied because it meant a holiday," the rule being that the men were not to go on the line when the temperature was less than —30° F. Going out from the camp that day on snow shoes Mr. Jenkins says "although it was cold at starting I was warm enough before I got back." The next night the temperature reached —58° F. and the third night —61° F.

"Now, according to all precedent we should have spent those three nights cowering with quaking hearts over the stove and using up the cook's fat to make the fires burn. As a matter of fact we went to bed as usual and slept without any fires at all. Not only that, but we suffered no discomfort. The only unpleasant thing about it was the turning out of one's blanket in the morning to light the fire and that I admit *was* cold but still nothing that a strong man could not stand with equanimity. But what will be thought when I state that during those three days of extreme cold Mr. and Mrs. Abrey were on their way from Battleford to Fort Pitt, *and slept out without any tent, and without keeping up a fire through the night?* If a Canadian surveyor's wife could do this, a Canadian surveyor can get to the North Pole. Mr. Jenkins regards the cause of drowsiness which is usually supposed to be produced by extreme cold, as rather attributable to exhaustion than to exposure to low temperature. On this point he says he has more than once 'walked fifty miles on snow shoes and never felt anything of the kind,' but he 'made it a rule to stop every four hours and draw some tea, and eat a good square meal.' He says 'when this practice is followed, it is astonishing how far a man can go without excessive fatigue.'"

The remainder of the article comprises a sketch of a plan for reaching the North Pole which in spite of probable criticism Mr. Jenkins ventures to present, assuming at the start that expense is simply no consideration whatever, and under the belief that if a feasible scheme is proposed "there is enough enterprise, private and governmental, among Anglo-Saxons, to carry it through, even if it cost a million."

The Measurement of Fusing Point Temperatures.

AN instrument for the determination of fusing points illustrated in the accompanying engraving was submitted to the chemical society of Paris in 1887 and has been described in *Industries and Iron* from which also the accompanying cut has been reproduced. Only as much of the article as is necessary to give an understanding of the operation of the instrument will be here reviewed, although the difficulties met with in the accurate determination of fusing points are made the subject of some interesting remarks. It is evident that the determination of melting points must present difficulties, since different observers, all admitted to be able experimenters, have sometimes differed in their determinations for the same material as much as 10° C.



This apparatus of Maquenne is designed to indicate the exact fusing points of materials with the application of second and third corrective terms to the readings taken by observation.

The apparatus consists essentially of a prismatic block B of red copper, drilled longitudinally a little below its upper surface in order to form a chamber wherein to place the thermometer Th., the latter giving very exact readings, and an exact indication of the temperature of the metal throughout. This block is supported by two vertical copper plates which protect the gas flame of the gas burner G from drafts coming in endwise. The whole is mounted on supports S. A gas-cock T regulates the flow of gas to the burner through R. Copper being one of the best conductors of heat, it is possible to heat it to 400° C., so uniformly that no correction is needed. Substances to be tested are placed in the small cavities *c* made in the upper surface of the copper block. The jets of gas issuing from the burner are controlled by the handle *m*, and by means of this and the regulating cock T a very sensitive adjustment of the heating power of the jets between temperatures below 100° C., up to the maximum temperature above named can be obtained. Of course substances which at any temperature react chemically upon copper cannot be tested in this instrument.

Maxim's Flying Machine.

AMONG the many articles short and long concerning the trial of Maxim's Flying Machine, there are few if any that convey so good an idea of the nature of the machine and the real significance of the results attained at the trial, as that published by *The Engineer* (London). The fact that the machine did actually fly through the air, and had to be held to keep it from flying away, as attested by numerous witnesses of high repute in the scientific and engineering world, must make the examiner in the U. S. Patent Office who rejected Mr. Maxim's application for a patent, on the ground that it was inoperative, feel rather cheap. This sapient individual not only refused to allow Mr. Maxim's application for a patent, but refused to admit any evidence that the machine is operative, unless a working model that would actually fly should be supplied to the office. As a model of the small size required by the U. S. patent office could not, by any amount of ingenuity, be made operative, the effect of the examiner's action, if not overruled on appeal (as it is certain to be), precludes Mr. Maxim from obtaining a patent. This certainly is a singular position for an inventor like Mr. Maxim to be placed in,—a man whose fame as a successful inventor is world-wide, and who is the very antipode of perpetual motion visionaries, in dealing with whom, the U. S. patent office has had to require models, because, only by the fact that their models obstinately refuse to work are the examiners generally able to demonstrate the inoperative character of such alleged inventions.

Some time, and at no distant day, the pluck, energy, skill, persistence, and lavish expenditure of money that have characterized the Maxim experiments, together with the enormous difficulties he has attacked and surmounted, will form the most brilliant chapter in the history of artificial flight. The patent office examiner who said the machine could not fly, and who refused to listen to such evidence as Mr. Maxim can bring to prove that it can fly, might possibly be rendered more useful to the office than he is at present by dispensing with his services.

The machine did fly. The engineer thus describes the experiment:

> We shall briefly glance over the occurrences of July 31 last, on which occasion the soaring tendency of the machine became so great as to overcome all the obstacles which were designed to retain it near the ground, and Mr. Maxim found himself in a somewhat similar position to that of Frankenstein when overpowered by the monster which he himself had fabricated and endowed with life. This is what happened: The machine had traveled some 1000 feet, the latter 550 feet of which it had flown, a fact which is clearly proved by the impressions made on the inverted guard rails. It appears that suddenly the lifting effort became so great that the frame work carrying the after retaining wheels became distorted to such a degree that the wheels failed of their office, and the afterpart of the machine became free; the forepart however, continuing to hold the machine down, but not for long, as the wobbling which ensued rendered steering impossible, and the machine got out of line with the track; the left hand front wheel also got free and the machine charged one of the timber supports carrying the right-hand guard rail, tore up the rail, which is simply a 9 inch by 3 inch plank, and did very great damage to its own framework. The ride was in this way brought to a sudden stop, and it will be several months before it can be renewed. The total weight of the machine, including 600 lbs. of water, 200 lbs. of naphtha and three men was about 8000 lbs.

The article then gives an illustrated description of the machine and details of its construction. These show in a pronounced manner the wonderful wealth of mechanical resource possessed by the gifted inventor.

What Mr. Maxim has done is, so to speak, to make a bird that does not know how to fly. We believe that the safe use of such a machine will always depend on the skill of the driver. Because we put on skates we do not expect to be able to skate right away. No more can we expect Mr, Maxim to be able to control this machine efficiently until he has had years of practice. In the same way there are birds who fly well and birds who fly badly. This bird has only just been hatched. Let us hope that Mr. Maxim will not come to grief, "Icarus like," before he is fully fledged.

No more interesting article than this has appeared in the technical literature of the month, as is well indicated by the fact that it has either been reprinted in full, or liberally quoted by an unusual number of publications.

A very graphic pen-picture of an experiment with the Maxim flying machine has been drawn by a reporter of the *Pall Mall Budget*. This description has been reprinted in the *Scientific American*, with an illustration of the scene that is presumably a fancy sketch, since it bears the imprint of the last named publication. In describing trials of new machines the average daily newspaper reporter, while apt to get tangled in attempted scientific explanations and go astray in the applicaton of technical terms perceives aspects that escape more acute scientific observers absorbed in the contemplation of the operation of devices, and intent upon observing accordance with or violations of mechanical principles in their construction. The reporter sees with the popular eye, and describes what he sees, or, at least what he thinks he sees,—sometimes what he does not see at all. In general, however, such reports present a more vivid impression of the scene as a whole, than could be expected from a technical writer. The following is an account as given by the reporter:

There was a hissing and spluttering as some pumps got to work, and then, presently, the port propeller began to revolve with a rapidly increasing whirr-r, and the cry went up to "look out." In a few seconds whirr-r-r went the starboard propeller also. The platform on which we stood rocked and quivered with vibration. A hurricane seemed to spring up, laying the hay flat far and wide, and scattering like a whirlwind the shavings in the workshop twenty yards away. Every one grabbed his hat with one hand, and clung for dear life with the other to a rail. Suddenly, when the tornado had reached its height, and the whole machine was shaking and straining at its anchor like a greyhound in the leash, a shrill whistle gave the order to "let go," and the huge structure bounded forward across the meadows with a smooth sailing motion, at a rate increasing up to forty miles an hour.

As the end of the track came in view a look of horror set in. There was nothing apparently but a quick-set hedge to arrest our wild career. A rope was stretched across the path. We crash through it. Then another; then another, and finally we come to rest in the easiest, gracefullest manner imaginable, within a few feet of what looked like perdition. Then we all laughed. It was a most delicious sensation, wiping out forever such tender memories as switchbacks, toboggans, and the seductive water chute. It was unique, in fact, and unlike anything that the world has ever seen; for the occurrence just described represents the crude residual impressions of a first trip over the rails on Mr. Maxim's giant flying machine.

The inventor beamed pleasantly as he noted the effect for he had a distinguished company on board. There were Lord Kelvin and Lord Rayleigh, Sir Douglas Galton, Professor Vernon Boys, Sir Guilford Molesworth, Earl Russell, Professor Pettigrew, of Edinburgh, and the science representative of the *Pall Mall Budget*. After the first trip there was a unanimous demand for a second, and the huge structure, weighing but some 7000 pounds in all, was pushed back along the rails on which it runs to the starting point, where steam was got up once more and the performance repeated.

INDEX TO LEADING ARTICLES.

*24234. Geology and Scenery in Ireland. Ill. (N–Aug. 2.) 600 w.

*24236. Pleistocene Climatic Changes. Warren Upham (G M–Aug.) 4300 w.

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†24714. Description of Tertiary Artiodactyls. Ill. O. C. Marsh (A J S–Sept.) 4800 w.

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*24752. Lighthouse Illuminants. James Kenward (G W–Aug. 25.) 2400 w.

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24825. Cold Storage. M. B. C. (G & F–Sept. 5.) 1700 w.

24827. The Soldiers' and Sailors' Monument, Cleveland, O. Ill. (Ml N–Sept.) 1300 w.

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*24922. The Navigable Balloon at the Antwerp Exhibition. Ill. (Eng L–Aug. 31.) 900 w.

*24929. Color Gauges for Carbon Testing. Walter G. McMillan (I C T–Aug. 31.) 4800 w,

*24934. Who Really Invented Cordite? Mr. Nobel's Further Appeal: Mr. Hiram Maxim's Claim to the Invention (Inv–Sept. 1.) 1800 w.

*24964. The Measurement of Fusing Point Temperature. Ill. (I & I—Aug. 31.) 800 w.

Serials.

20214. A General Review of Existing Artillery. Gaston Moch (J M S I–Began March—4 parts to date—75 cts. each).

21763. Engineering Practice and Education. Gaetano Lanza (J F I–Began May—5 parts to date—45 cts. each).

22848. Physical Units. Magnus Maclean (E E L–Began June 8—7 parts to date—30 cts. each).

23406. Notes on Russian Geology. W. F. Hume (G M–Began July—Ended Aug.—2 parts—30 cts. each).

23443. Sculptured Monuments of Boston. Ill. Thomas Ball (Ml N–Began July—3 parts to date—15 cts. each).

23965. Photometry. W. De W. Abney (J S A–Began July 20—3 parts to date—30 cts. each).

24235. On the Newtonian Constant of Gravitation. Ill. C. V. Boys (N–Began Aug. 2—3 parts to date—30 cts. each).

24076. Theory and Practice of Refrigeration (I & I–Began July 27—3 parts to date—30 cts. each).

24240. On Some Life Zones in the Lower Palæozoic Rocks of the British Areas, as Defined Mainly by Researches During the Past Thirty Years. Henry Hicks (G M–Began Aug.—1 part to date—30 cts).

24360. The Manufacture of Smokeless Powder. Oscar Guttmann (Sc A S–Began Aug. 18—Ended Aug. 25—2 parts—15 cts. each).

24433. Pyrometry. C. R. Alder Wright (I & I–Began Aug. 10—Ended Aug. 31—4 parts—30 cts. each).

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng–Began Aug. 10—2 parts to date—30 cts. each).

24600. China and Japan (I C B–Began Aug. 17—Ended Aug. 24—2 parts—30 cts. each).

24692. Turrets in the Forts on the Line of the Meuse. Lansing H. Beach (J M S I–Began Sept.—1 part to date—75 cts).

NEW BOOKS OF THE MONTH

Alternating Current Wiring and Distribution. By William LeRoy Emmett, E. E. New York: *The Electrical Engineer*. [Cloth. 12mo. 76 pp. $1.]

In a discussion in the British Institution of Electrical Engineers not many months ago. Mr. Kapp remarked that an impression which seemed generally prevalent, that alternating motors were still in the experimental stage, and were not to be relied on for practical work, was due to the fact that it was the fashion for the English electrical journals to cry down multiphase and alternating-current work. He sympathized, however, with the editors who, as he very justly remarked, " must find it very inconvenient to have to take up new subjects of study so as to be able to write intelligently about them." But the phenomena of alternating currents is a subject about which it is not so easy to write intelligently, or at all events clearly, even when one has himself sufficiently well mastered it. Mr. Emmett says in his preface that he has undertaken to explain the laws governing the distribution of alternating currents in such a manner as to make them intelligible to practical men, " without the expenditure of time necessary to the study of complete works on the subject." In this commendable undertaking we fear that he will be found to have met with only partial success. His elementary explanations are not only lacking in fullness, but, at times, are deficient in clearness as well,—faults obviously not due to any deficiency of knowledge on the part of the author, but rather to unskillfulness in presentation. For example, on page 9 it is stated that counter-electromotive forces " are caused by periodic variations in the current which cause changes in the magnetic flux through the circuit." Of course these forces may equally well be caused by variations which are not periodic, while the expression " magnetic flux through the circuit," though perfectly intelligible to the tyro, conveys no meaning whatever to the average student or practical man. Nor is the matter much helped by the attempted explanation in the next sentence, in which we are told that " the wires carrying the current are encircled by lines of magnetic force, and many of these lines generally pass through the circuit." Again, on page 8, in speaking of the tendency of alternating currents to seek the surface of the conductor, it is said: " It is easy to understand that this effect is relatively greater with large wires than small; also that it will be much greater with iron than with copper wires." Now the latter is an effect that is by no means " easy to understand," especially in the absence of the slightest attempt at elucidation.

Having briefly indicated what we conceive to be the principal fault of Mr. Emmett's work, we pass to the principal subject-matter, viz., a consideration of the practical aspects of alternating distribution. Of this portion of the work we feel justified in speaking in terms of high praise. It is seldom that so much really useful information is condensed into so small a space. Both the diphase and the triphase systems are discussed, and the characteristics of each pointed out. The conclusion of the author is, that for a system of town distribution, under the conditions which usually prevail in this country, secondary mains, preferably on the three-wire arrangement, with transformers installed in large units, will be found to give more satisfactory results as to economy and regulation than any other. The author gives the reasons for his opinion with sufficient fullness, and they seem to us to be conclusive. Such a system of secondary mains obviously becomes the more desirable in view of the modern tendency to make use of a single organization of distributing conductors for all classes of electric service.

In case a second edition of Mr. Emmett's is called for, the nomenclature of the different phenomena of the alternating circuit might advantageously undergo some changes. The introduction of the term "reactance," under the sanction of the American Institute of Electrical Engineers, in lieu of "inductive," resistance happily renders it possible to dispense forevermore with that absurd phrase "ohmic" resistance, which, as the late George Prescott once wittily remarked, is as if one should speak of the "feetic" length or the "poundic" weight of a conducting wire. The book is neatly printed in clear, open type, and is illustrated with an abundance of diagrams. Altogether, it will be found a useful addition to the library of the electrical engineer.

FRANKLIN L. POPE.

THE ANIMAL AS A PRIME MOTOR, AND THE LAWS OF Energetics. By R. H. Thurston. New York: John Wiley & Sons.

THIS book, a monograph of 97 pages, gives in an introduction and in concise and comprehensive form, fundamental definitions and principles involved in the study and discussion of energy, the forces in which the author perceives the "characterizing attributes of the universe" (a profound generalization which has never been better expressed), mechanics and energetics, a discussion of the relations of matter, force and energy, laws of energetics, Newton's laws and the algebraic expression of energy-changes. The introduction then proceeds to the considerations of the object of all mechanism, sources and kinds of energy, and forms of motor, including the animal body, which latter he styles "a vital machine." Having thus led up to the theme of the work, the author enters a region of speculative thought of transcendent interest, namely, the vital processes by which motive power is supplied to animal mechanism. Of the nature of this power ignorance is frankly confessed; but the work clearly shows that the animal machine is not thermodynamic in the sense in which that word is now generally used, although the unknown vital processes produce heat, light and electricity as do heat engines when employed to generate these forces. In the present state of science, two facts only may be positively formulated with reference to vital processes. These are chemical changes in alimentary substances and in living tissue, and the result, in the production of the forces named, together with mechanical energy and a series of mental and emotional phenomena that appear to differ widely from any of the forces and phenomena dealt with in physical science. It is seen, however, that considered purely as a machine with relation to the development of mechanical energy and the performance of work, the vital animal structure is very much more efficient than any heat engine devised by human ingenuity. The book is one for thoughtful readers, and it is suggestive of immense possibilities to the human family when it is learned how to render the action of artificial motors more nearly like that of animal machines. Early in the book occurs the following pregnant sentence indicative of the trend of modern scientific thought. "We are gradually progressing towards the establishment of a law of persistence of all existence, whether of matter, of force and energy, or of organic vitality, and perhaps even to its extension until it includes soul and intellectual life."

LEICESTER ALLEN.

MICRO-ORGANISMS IN WATER: THEIR SIGNIFICANCE, Identification and Removal; together with an Account of the Bacteriological Methods Involved in their Investigation. Specially Designed for the use of those connected with the Sanitary Aspects of Water Supply. By Percy Frankland, Ph. D., B. Sc., F. R. S., etc., and Mrs. Percy Frankland, joint author of "Studies on Some New Micro-Organisms Obtained from Air." London and New York: Longmans, Green & Co. [Cloth, 8vo, xi.-532 p. With 2 plates and numerous diagrams.]

ALTHOUGH the literature of the bacteriology of water has grown to extensive proportions, notwithstanding the comparative newness of the science, publications on the subject are for the most part desultory and scattered through official reports, the transactions of societies and the scientific periodicals. The present work has the merit of bringing together in connected form accounts of the various and more important investigations in this branch of bacteriology, and should prove serviceable not only to students and investigators but also to those who, like engineers and health officers, are practically concerned with the hygienic aspects of water supply. The methods of sterilization and preparation of culture media and the staining and microscopic examination of micro-organisms are described very thoroughly in the opening chapters. Other chapters are devoted to discussion of the bacterial contents of waters, the multiplication of micro-organisms, the detection of disease-breeding bacteria, the vitality of particular pathogenic bacteria in different waters, and the comparatively novel subject of the bacteriological action of light. An appendix contains a concise and systematic description of the more than 200 forms of micro-organisms hitherto found in water, which serves as a convenient reference for identifying the various species.

To sanitary and hydraulic engineers the most interesting portion of the book is that devoted to the purification of water for drinking purposes, in the water supply of cities and in domestic use. The hundred pages in chapter V on this head are most instructive, and, as would be anticipated from Professor Frankland's wide experience and high reputation as a specialist, the practical details are well and analytically worked out. Lessons are drawn from the experience of sand-filtration in the water supply of London, Berlin, Hamburg-Altona, Zurich and many other places, and from numerous experimental researches, including those of the Massachusetts board of health, which cannot fail to be of service to those operating or contemplating the installation of municipal water-purification works. The author lays down the following law, the applicability of which has been proved in practice to such a degree that predictions as to efficiency made on theoretical considerations are borne out with precision in actual practice:

> The factors which, in my opinion, are more especially calculated to influence the number of micro-organisms present in the distributed [filtered] water are the following:
>
> 1. Storage capacity for unfiltered water.
> 2. Thickness of *fine* sand through which filtration is carried on.
> 3. Rate of filtration.
> 4. Renewal of filter-beds.

The mere enunciation of these self-evident propositions does not convey an adequate idea of the manner in which they are elaborated as to details, for which the reader must be referred to the original text.

Throughout the book one is impressed with the radical revolution in scientific thought as to water contamination, putrefaction, and the origin and propagation of zymotic diseases, in so short a period as twenty-five years, or since the time when the authority of Liebig upheld the theory that organic substances in the act of decomposition are capable of causing the alteration and decay of other substances (as in fermentation), and beginning with the classic researches of Pasteur, Koch, and the new school of investigators, who have proved that living organisms are the cause of some, and possibly of all, zymotic diseases. In the case of two diseases, at least—Asiatic cholera and typhoid fever—the evidence may now be considered conclusive. This reversal of opinion and the establishment of the germ theory of disease (at any rate in part) have had a direct bearing upon systems of water purification. Whereas formerly the total organic contents of water was deemed the cruclal point, now we look to the relative numbers of pathogenic bacteria. In other words, the work of the chemist, while by no means wholly displaced, must be supplemented by and made secondary to that of the microscopist and bacteriological specialist.

A. W., JR.

HOW TO BECOME A SUCCESSFUL ELECTRICIAN: The Studies to be Followed, Methods of Work, Fields of Operation and Ethics of the Profession. By T. O'Conor Sloane, Ph. D. Illustrated. New York: Norman W. Henley & Co. [12mo, Cloth, p. 8-190. $1.]

IT is much to be regretted that in too many cases the latter-day publisher fails to grasp the important truth, that a book, like an individual, often fails to receive the recognition to which it is entitled by its intrinsic merits, by reason of its unattractive exterior. Any one who should chance to see this work lying upon a bookseller's counter, and should note its cheap looking binding, with the title stamped upon the cover in a tasteless tangle of fancy lettering done in aluminum leaf and interspersed with a profusion of conventional zig-zags misrepresenting lightning, would naturally expect to find within nothing more useful or instructive than a collection of well-worn newspaper anecdotes of electrical "wizards," interspersed with platitudes more or less stale and unprofitable, and probably in nine cases out of ten, would not take the trouble even to open it. Every rule, however, is said to have exceptions, and the present work is most emphatically one of the exceptions. The world has hitherto had more than enough of treatises professing to point out to ambitious youth the short and easy road to that which is usually understood as "success,"—namely, material wealth. "He began poor and ended rich"—these few words usually tell the whole story. "It seems a hard thing to say"—says our author—"that honor and honesty are not in themselves favorable to the accumulation of a fortune." Yet in these latter days it cannot be denied that the truth of this axiom is being more and more forced upon our attention. If an engineer is to gain a high degree of professional success, money-getting must be incidental to his work, and only in a very minor sense a part of it, or he cannot render really valuable service to mankind. This view of the professional aim of the electrical engineer is strongly insisted upon by Mr. Sloane from first to last. He does not fail to point out that the professional man who seeks other success than wealth must, as a rule, content himself with other rewards than those which wealth can bring. He inculcates thoroughness, honesty, truthfulness, open-mindedness in all things. These, however, are but generalities. He points out how and by what means the ambitious youth who may perchance by untoward circumstances be prevented from entering upon a technical or collegiate course, may pursue a course of self-education which, with pluck and determination, will ultimately bring him to the desired goal. No attempt is made to disguise or underrate the difficulties of the task. Every chapter, indeed almost every sentence, is replete with useful knowledge, helpful suggestion and strong common-sense. The engineer, mechanic or student, electrical and otherwise, will find here in abundance mental stimulus judiciously intermingled with practical instruction. Seldom, indeed, have we met with a work of this kind in which there is so little to criticise and so much to commend.

FRANKLIN L. POPE.

A Text-Book on Roofs and Bridges. Part III, Bridge Design. By Mansfield Merriman, professor of civil engineering in Lehigh university, and Henry S. Jacoby, associate professor of civil engineering in Cornell university. First edition; first thousand. New York: John Wiley & Sons. [Cloth, 8vo, viii-425 p. With numerous plates and diagrams. $5.]

THIS volume includes the design of plate girders, lattice-trusses and pin-connected bridges, together with the proportioning of details, in accordance with advanced modern practice and especially adapted to the use of students, though the practising engineer will find in it much useful material. As a text-book, the work is admirably analytical and progressive, the logical sequence of topics being carefully observed. The authors have had in view two leading motives—(1) the presentation of the subject rationally and as an application of the principles of mechanics; and (2) practically, as an illustration of modern economic structures. These two phases, so essential in the discussion, are necessarily blended, as they must be in practice to secure proper strength and greatest economy. Attention is confined to simple bridges, those resting on two supports, which class includes probably over ninety per cent. of all bridges and furnishes the best examples for the study of bridge design. While railroad bridges are given prominence, for illustration of other cases two highway structures for electric-car traffic are included, two chapters are devoted to roof trusses and another to elevated railways. In the typical examples selected the design is based on complete computations, as in a roof-truss, a plate-girder bridge, a pin-bridge and a riveted bridge. Somewhat heavier sections are derived than is usual in practice, though this is offset by the many examples of actual structures. The two first chapters contain a critical and historical summary of the whole field, with references to the bibliography of the subject. The three chapters on shop methods will be welcomed as containing information not readily accessible in print. In addition to the work of the authors themselves, the utility of the volume is enhanced by contributions from several distinguished bridge designers, these additions coming in harmony with the main course of the discussion. Within the limits set by the authors, the work is very thorough and can be heartily commended for its ostensible purpose, that of a text-book for students of civil engineering.

LABORATORY MANUAL OF PHYSICS AND APPLIED ELECTRICITY. Arranged and edited by Edward L. Nichols, Prof. of Physics in Cornell University. In two volumes. Vol. I. Junior Course in General Physics by Ernest Merritt and Frederick J. Rogers. New York: Macmillan and Co. [Cloth, 8vo., 294 p. Illustrated. $3.00.]

AS announced in the preface this book in its present form is the work chiefly of Assistant Professors George S. Moler, Ernest Merritt, and Frederick Bedell, of Instructors Frederick J. Rogers, Homer J. Hotchkiss, Charles P. Matthews, and of the editor.

The plan of the book, which as its title would indicate, is intended as a laboratory manual or textbook, has not been to provide a complete source of information for laboratory students but rather to furnish an outline which shall be filled in by the student by reference to larger works devoted more exclusively to the various special subjects which go to make up a complete course in physics and applied electricity.

The manual has been divided into two volumes and is designed for three classes of students differing from each other in experience, maturity and purpose, and the method of treatment has varied accordingly. This, the first volume, is intended for beginners, and therefore affords more specific directions, more demonstration than will the second volume. It also contains not infrequently elementary statements of principles, which will be omitted, it is announced in the second volume.

It is assumed in this volume that the student possesses some knowledge of analytical geometry and the calculus; also that he has completed a text book and lecture course in the principles of physics. The experiments have been divided into groups, an arrangement for which the editor assigns the following two reasons: 1. "On the one hand it serves to guide the practicant and the instructor in the selection of experiments," and 2, "it furthers the development of the system by making it easy to add or exclude material."

The book is printed in clear distinct type on heavy tinted paper and sufficiently illustrated with simple outline cuts which we are happy to say are not reproductions of cuts that have done service for a generation or more, but were evidently prepared for the occasion. Among these cuts are a number of candle power curves, and the book closes with tables of logarithms, natural series, cosines-tangents and cotangents following Bottomley's arrangement of four-figure mathematical tables.

A LABORATORY MANUAL OF PHYSICS AND APPLIED ELECTRICITY. Arranged and Edited by Edward L. Nichols, Professor of Physics in Cornell University. Vol. II, Senior Courses and Outlines of Advanced Work. By George S. Moler, Frederick Bedell, H. J. Hotchkiss, Chas. P. Matthews and the Editor. New York: Macmillan & Co. [Cloth, 8vo, 436 p. With Diagrams. $3.25.]

THE first volume of this manual consists of a laboratory course in general physics for beginners, with explicit directions as to the method of manipulation and the arrangement of results. Volume II is intended for students who have completed such a course and who are prepared to take up special work. Especial attention has been given to the needs of those in training to become electrical engineers. The several parts of this volume are divided as follow: Part I, experiments with direct-current apparatus; Part II, experiments with alternating currents; Part III, senior courses in heat and photometry; Part IV, outlines of advanced work in general physics.

Annual Reports of the Committees of Council, officers and departments of the city of Atlanta (Georgia), for the year ending December 31, 1893; showing the condition of municipal affairs. The Foote & Davies Co., Atlanta. 1894. [Leather, 8vo, 767 p. With cuts and maps.]

No more active or progressive a place could be named than Atlanta, and Atlanta justifies her reputation by the reports which she puts forth, and is fairly entitled to the advertisement entailed in them. The general business depression does not seem to have hit Atlanta very hard, the city's credit having been fully maintained and much public work having been carried on. The receipts and disbursements for the year may be stated at $2,000,000 each, in round numbers, and the expenditures appear to have been made in the direction of a liberal spirit of public improvement and government. If any adverse criticism is in order, the general tenor of the reports might be said to carry the impression that Atlanta is perhaps governed a little too carefully. Other cities may be lax in this respect—Atlanta certainly is not.

A Dictionary of Electrical Words, Terms and Phrases. By Edwin J. Houston, A. M., Ph. D. Third edition, with appendix, greatly enlarged. New York: The W. J. Johnston Co., Lt'd. [Cloth, 8vo, 669 double column p. 582 illustrations. $5.]

Recent development in the electrical transmission of power has brought forward the subject of multiphased alternating currents, the rotary magnetic field and many phenomena new to industrial electricity; and in other branches the progress has been so rapid as to introduce a large number of new terms which are as yet scarcely to be met in electrical books. For this reason and because of the exhaustion of former editions, the appearance of this latest and third edition of Professor Houston's standard dictionary is timely. The additions amount to about 20 per cent. and are intended to bring the work down to the year 1894. Among the new electrical words, terms and phrases introduced in the last two years and incorporated in the present dictionary are included the results of the work of the World's Fair international electrical congress and of the committee on units and standards of the American institute of electrical engineers, with also proposed nomenclature from less authoritative sources, but which nevertheless is likely to be encountered by the reader. A careful system of cross-references has been adopted, to facilitate consultation. The dictionary is well gotten up typographically.

The "Practical Engineer" Pocket-Book and Diary. Edited by W. H. Fowler, M. Inst. M. E. Manchester, England: Technical Publishing Co. [Roan 16mo. 229 p. 1*s*. 6*d*.]

Here are given the tables, formulæ, and diagrams, and other information usually found in pocket-books intended for the mechanical engineer. It contains also a diary with spaces for each day in the year and closes with ruled blank pages for memoranda.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Special mention is due, among the catalogues lately received in this office, to a mammoth "Illustrated Catalogue of Railway and Machinists' Tools and Supplies," issued by Manning, Maxwell & Moore, Nos. 111-113 Liberty street, New York, to indicate the unusually large line of products which they keep in stock or are able to supply on short notice. This is a substantially bound quarto volume (11×13 inches) of 1103 pages, embracing from two to a dozen well-executed engravings of tools or machines on every page, together with suitable descriptive matter and, in many cases, price lists. No fewer than thirteen three-column pages are devoted to an alphabetical index in the front part of the volume, embodying a marvelous range of mechanical aids throughout the entire alphabet, from "accumulators" to "zinc tubing." The appearance of the book is alone a strong guarantee of the high character of the house producing it.

The Tanite Company, Stroudsburg, Pa. = Catalogue of 1894. 47 p. [Facts relating to emery, and description and prices of Tanite emery wheels.]

Felt and Tarrant Manufacturing Company, Chicago. = Mechanical Arithmetic. 28 p. [Description of the Comptometer, with a statement of its advantages over mental work in making calculations.]

Westinghouse Electric Manufacturing Company, Pittsburgh.=Multipolar generators and motors. 16 p. [Illustrations and descriptions of apparatus from ¾ horse-power up.]

Singer Elevator Safety Stop Company, New York.=Unsafe Made Safe. 16 p. [Illustrations in detail of safety-stops for elevators.]

W. & L. E. Gurley, Troy, N. Y.=A Manual of the Principal Instruments used in American Engineering and Surveying. 372 p. [Fully illustrated with description and price-lists of engineering and surveying instruments.]

The Bridgeport Wood Finishing Company, New Milford, Conn.=General trade catalogue. 50 p. [Descriptive price-list of paints, finishes, etc., together with valuable suggestions as to their application.]

Indianapolis Terra-Cotta Company, Indianapolis, Ind.=General trade catalogue. [Carefully prepared publication with excellent illustrations of terra-cotta, tiles, etc., manufactured.]

The Raritan Hollow and Porous Brick Company, New York.=Fire-Proof Building Material. 85 p. [Handsomely gotten-up publication with illustrations and descriptive text of porous brick, terra-cotta, etc. Of interest to contractors and builders.]

William Whitlock, New York.=The National Chuck. 25 p. [Illustrated descriptive catalogue and price-list.]

Schaeffer & Budenberg, Brooklyn, N. Y.=General trade catalogue, 163-iii p. [Carefully compiled publication descriptive of pressure and vacuum gauges, injectors, and boiler appliances in general.]

John Maslin & Son, Jersey City, N. J.=Maslin Pump and Machine Works. 42 p. [Illustrated descriptive price list of hoisting engines, tubular boilers, steam drums, etc.]

The Ball & Wood Co., New York.=General catalogue. 36 p. [An artistic publication containing a treatise on the development of high-speed automatic cut-off engines.]

United States Mineral Wool Company, New York.=The Uses of Mineral Wool. 36 p. [Contains in concise form a description of the various uses to which mineral wool is especially adapted.]

D. Saunders' Sons, Yonkers, N. Y.=General catalogue. 90 p. [Illustrated descriptive publication of pipe and thread cutting machines, dies, pipe vises, etc.]

J. H. Lau & Co., New York.=General catalogue of sporting goods. 52 p. [Contains in addition to general sporting goods description of their Eagle blasting caps, which have been largely used in mining operations.]

Weston Engine Company, Painted Post, N. Y.=General catalogue. 27 p. [Contains full description, with illustrations, of the Weston automatic engine.]

Hilles and Jones Company, Wilmington, Del.=New and Improved Machine Tools. 32 p. [Contains illustrations of new machine tools for use of iron ship-yards, bridge works, etc., with special machines for working plate and shape iron.]

Dalton-Ingersoll Company, Boston.=Fine Sanitary Specialties. 323 p. [One of the handsomest and most comprehensive trade publications which has come under our notice, giving full description and price-list of various sanitary appliances. Of special interest to architects and builders.]

The New York Safety Steam Power Company, New York. Catalogue A, No. 24. 51 p. [Contains description of Safety steam engines, with points on lubrication and care of engines.]

The Heine Safety Boiler Company, St. Louis, Mo.="Helios." 161 p. [One of the handsomest trade publications which has come under our notice, setting forth the merits of the Safety boiler, with illustrations and descriptive matter. Will prove an excellent hand-book as it contains much valuable information.]

The De La Vergne Refrigerating Machine Company, New York.=Mechanical Refrigeration. 96 p. [Processes and apparatus of the company described, with full descriptive text and illustrations. Will prove of great value to those interested in mechanical refrigeration and ice-making.]

Wiley & Russel Manufacturing Co., Greenfield, Mass.=General Catalogue. 168 p. [Neat and comprehensive trade publication of patent screw cutting and other labor-saving machinery and tools.]

Standard Electric Company, Chicago, Ill.=The Standard System of Dynamo-Electric Machinery and Accessories. 87 p. [Giving in brief, with excellent illustrations, descriptions of Standard Electric appliances and dynamos, etc.]

Fred Bredel, C. E., New York.=Retort Houses and Retort Benches. 64 p. [Illustrations and descriptions of gas-retorts, of interest to those contemplating the erection or extension of gas-plants.]

W. R. Brixey, New York.=Kerite Insulated Wires and Cables. 47 p. [General descriptive price-list of telegraph, telephone, electric light and signal wires, with points on the use of Kerite insulation.]

The American Well Works, Aurora, Ill=Illustrated trade catalogue. [Full descriptions of boring machinery, wind-mills, etc.]

Ball-Ball Company, Frankford, Philadelphia.=Drawing Instruments. 24 p. [Descriptive of drawing instruments manufactured.]

Pittsburgh Terra Cotta Lumber Co., Pittsburgh.=General trade catalogue. 26 p. [Descriptive of terra-cotta lumber as a fire-proofing material; of interest to builders, architects, etc.]

P. Blaisdell & Co., Worcester, Mass.=Catalogue of Machinists' tools. 24 p. [Contains full descriptions of upright drills, engine-lathes, planes, etc.]

The Battle Creek Machinery Company, Battle Creek, Mich.=The Marsh Steam Pump. 32 p. [Contains a treatise on steam-condensation, with illustrations of apparatus.]

J. A. Fay & Co., Cincinnati, Ohio.=Wood-Workers' Machinery Supplies. 87 p. [Descriptive price-list and telegraph code combined, compact and comprehensive.]

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THE CAUSES AND EFFECTS OF GREAT FOREST FIRES.

By John Gifford.

WHEN the early settlers landed on American shores this country, excepting the great western plains and deserts, was covered with an unbroken stretch of beautiful forest, surpassing in variety and value that of any other country in the temperate zone. The advancement and prosperity of the American people depended mainly on this great resource. For more than three centuries it has been recklessly cut and shamefully burnt. Only a remnant of this great inheritance remains.

Epidemics and conflagrations are usually caused by the carelessness or maliciousness of mankind, and both are therefore preventable. It is a blot on our civilization to allow such devastation. Widespread suffering and destruction can only be due to ignorance and callousness on the part of the people. A strong public sentiment needs therefore to be aroused and a remedy will present itself.

For several days recently a cloud of smoke hung over the land and was even blown far over the sea causing a heavy fog along our shores; the sun was dimmed and reddened and the newspapers were filled with descriptions of horrible scenes of death and desolation, due to that prince of enemies, the forest fire. During the latter part of August the American Forestry Association, at the midsummer meeting in the White Mountains, discussed many times the question of fires, and all the while those beautiful valleys were full of smoke from Vermont, where thousands of spruce trees fit for paper pulp were burning.

What we need and what we must finally have in America, is forest regulation. The great work of the forester is to so direct nature as to

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always produce the largest amount of useful forest products on the smallest area possible, with the least expense. It is, in other words, to keep the earth so dotted with evenly distributed woods that the increment will equal all the needs of mankind, while the principal will remain untouched to exert its influence in lessening the destructive forces of nature and in beautifying the earth.

We waste timber. Owing to its abundance at present it enters into the majority of constructions, while architects agree that brick and stone are not only better, but in the end cheaper. The government must do its part in setting aside and carefully caring for large masses of trees in places unfit for agriculture. The farmer must do his part, which is the important part, in growing a few acres of trees on his farm where the soil is poor, not only to furnish him with fuel and lumber but to shield his crops. A small tract of forest may yield many minor products by no means minor in importance to our needy farmers. Pine-knots may be slivered and sold by the bunch in cities at a good price. Even pitch was once extracted from our common pitch pine. Sassafras and cedar yield valuable oils and a still for the process is not expensive. Many low waste places are fit for the growing of basket willows. The black oak and other trees yield tannin and dye. At one time in south Jersey the gathering of sumac leaves for tanning was an important industry. For many years the sumac has been cultivated in Sicily. The woods of many trees are fitted for special uses: the bilsted for market baskets, the persimmon (the only northern representative of the ebony family) for shuttles, white cedar for hollow-ware, maples for sugar, pine slabs for paper, holly for fancy articles, or the chestnut and walnut which need little care and yield handsome returns. From a forestry standpoint underbrush is of value. Let the farmer grow the huckleberry, laurel for rustic work, or many other shrubs which will increase his income, and at the same time preserve forest conditions on a small part of his land. Unity in this respect on the part of the farmers will support many small industries in every locality, and then the forests will become evenly distributed in small well-cared-for patches over all the country. This is the true solution of the forest fire problem.

Our forests at present need simply common sense management. They have had practically no attention except when ready to cut. Trees are allowed to grow like weeds. The largest and best are used first, so that our woods have constantly deteriorated in consequence. The weakest and best must be nurtured, especially while young, else they seldom reach maturity. The writer believes that the absence of trees on our plains is due as much to fire and cattle as to soil and climatic conditions. The first great step is to keep out fire and cattle.

They have done more damage than the woodman's axe. It must be borne in mind that the main difference between a lumberman and a forester is that one uses the axe carelessly, the other with care; the one is endeavoring to fill his pockets with golden shekels just as soon as possible, while the other is content with a smaller and slower but perpetual income.

It is mainly the object of this paper, however, to explain the ultimate effects of forest fire and suggest a means of prevention. It is not necessary for us to dwell upon the enormous loss of life, buildings, timber, etc. We are all familiar with the awful calamities in the northwest, and we can all appreciate the fact that the damage is beyond calculation; but the destruction of standing timber is always insignificant compared with the ultimate effects of fire.

What applies to one section will not of course apply to another, owing to differences in species, in climate, soil, etc. A thorough study of each variety of tree is necessary in order to tell under what conditions it thrives best. Some trees grow better in company with others; certain varieties thrive best in an unmixed forest. Light and shade, rapidity of growth and a variety of conditions must all be considered, and from these data local forestry methods can be devised. Each locality, geographically distinct, must be studied apart from its neighbors. A fire, for instance, is much more easily handled in a level white oak country than in a pine woods on a mountain side. Nowhere, however, to my knowledge, is the consequential damage by fires better illustrated than in the southern part of the State of New Jersey. There for many years, near the largest population centers in America, fires have been raging. They have been burning many times over the same territory, so that the country is impoverished in consequence. Years of legislation and careful reforestation will be necessary before we can again produce such a forest cover as the original.

The region could once boast of large swamps of excellent cedar, forests of pitch-pine and several kinds of oaks. Ship building was once a flourishing industry, and long ago enormous quantities of charcoal were used in the manufacture of iron from a peculiar deposit which was raised out of the bogs. Many cords of firewood are still devoured by glass factories.

The section referred to is about twenty-five hundred square miles in area. It is known as the coastal plain or southern interior. Excepting along the shore, and here and there along the rivers and railroads, it is still an unbroken stretch of scrubby woodland—patches of savanna land and areas of stunted pine, the largest of which is known as the "plains." Here and there are whole forests of the black boles of trees which have been killed by fire, and occasionally in isolated protected positions are small clumps of beautiful woods characterized by their variety and rapidity of growth. Being the trysting place of the northern and southern floras and favored by a mild climate, a good forest soil, and the proximity to large bodies of water, a great variety of trees can and have flourished there. But the upland is covered with a mangy-looking growth of scrubby trees. Game is scarce, the water supply uncertain, and agriculture neglected. The infernal fires have converted a beautifully wooded region into what is practically a sandy plain. Considering all things it is less prosperous to-day than it was a century ago.

Forest fires are started in four ways: incendiaries, careless individuals, locomotives, and lightning. By far the most serious sources of origin are the criminal dastards who purposely set them, since they select the proper place at the proper time. By means of fire wood-thieves hide their tracks, and many people out of revenge fire an enemy's woods. Years ago charcoal burners set fire to woods in order to buy the charred wood cheaply since it was then fit only for charcoal.

Another serious cause, chargeable to gunners, tramps, and boys in the woods, is carelessness—mainly from the embers of a camp-fire, a lighted match, cigar or cigarette. That locomotives set many fires there can be no doubt. But this can be wholly prevented by the use of the spark arrester, by having places especially prepared for dumping hot coals, and by clearing and ploughing the land for several feet along the road. Careful train-hands are also of course necessary. Often, however, to produce a better draft the arrester is removed or poked with holes, and hot coals are carelessly emptied where they quickly generate a fire. Several fires in south Jersey have been caused by lightning, but this of course only very rarely results in damaging fires because the rains which follow are apt to quench them.

Forest fires burn about six months of the year, and are probably more destructive early in the spring than at other seasons. Many dry leaves have then accumulated on the ground, many still cling to the trees, the wood contains little sap, and the wind has a freer sweep.

A large foreign element has come to south Jersey to clear farms. This much increases the danger from fires owing to the burning of brush and carelessness of workmen. But when cleared these little farms check the headway of a fire. The sooner the forest-cover is distributed in many small patches over the country the better. There will then be no danger from enormous fires, except perhaps in government reservations on large tracts of waste land. Even then, if these be properly regulated and guarded, there can be but little danger.

Fire is very destructive to cranberry bogs and cedar swamps. It is necessary to dig deep trenches in order to check its headway, because it burns deep into the peat and appears here and there in unexpected places several feet away. The bed of a cedar swamp consists of several feet of humus. The bottom is covered with logs, ferns and spongy mosses. The principal moss is sphagnum which is collected and baled for nurserymen. It is used in packing plants for shipment, owing to its ability to hold moisture. Let me emphasize the value of this moss. Although almost indispensable to the florist, its collection ought to be prohibited at least to a certain extent. Noted for its ability to retain moisture, it can undergo an extreme amount of desiccation and still recover. In these swamps streams divide into many streamlets which percolate throughout this mass of material. The foliage of the cedar is so dense that the sun only feebly penetrates. Rain is retained and instead of rushing in a flood to the sea or rapidly evaporating is restrained and gradually distributed. Cedar forests are therefore natural reservoirs of water, effecting a natural irrigation ; but the owners of them, for fear of fires, cut the trees in a sappy state when fit only for an inferior grade of shingles and laths, or even hop-poles and rails. An uncertain water-supply is of course the result, since all the rivers of south Jersey rise in swamps and bogs within its own borders.

Young timber is usually killed above ground by fire. Large timber often apparently recovers, but it is always more or less affected. Its vitality is reduced so that insects invade and devour it, and charred wood is always of less value because disagreeable to handle. From the stump of burnt or cut oak many scions spring. These were used for hoop-poles a few years ago, but now, owing to the substitution of bags for barrels and iron for wooden hoops, there is practically no demand. The butts are often gathered, however, for umbrella handles. Some trees can endure more heat than others. The fittest in that respect survive, while other more valuable species perish. The pines are rapidly disappearing, and if fires continue there will be nothing whatever left to hold these sands but low scrub oaks and other brush.

The main reason why oak follows pine is that no second growth comes from a pine stump. When a pine is cut or burnt shoots spring from the collar of the stump, but soon wither and die. Second growth oak is vigorous, although it is claimed that a plant reproduced for any length of time in an asexual manner weakens. Young pines have difficulty in growing in underbrush, but an abandoned field comes up in pine and red cedar. A pine forest is apt to contain an oak here and there, sufficient to seed it, the acorns having been accidentally carried by squirrels or other animals. The effect of fires on seeds is an important question in determining the growth which follows. Some seeds are quickened by heat, others easily perish. It is certain that some are very easily affected by changes in temperature. Tropical seeds often lose their vitality when carried around Cape Horn. There is an interesting plant known as the fire-weed which comes up in abundance in burnt places. One can often locate the site of an old coal pit by a mass of this plant. It is of course not likely that the seeds have endured the heat, but upon fresh seeding it is the first species able to endure the conditions produced by a fire.

When a swamp-bottom is burnt it often comes up in white cedar, as even and dense as a field of wheat, while a swamp which has been cut and not burnt produces a great variety of trees. Although a common observation this is more or less of accidental occurrence. A swamp bottom is always well seeded with several kinds of trees and shrubs. A fire not only destroys these seeds but forms a soil on the surface. If this occurs when the cedar is in fruit its light winged seeds are quickly sown by the wind. Acorns sink into the soft sand but the light pine seeds remain on the surface and are quickly burnt by a passing fire.

Fires seriously affect sandy soils. They burn all the organic matter on the surface, the ashes are beaten by rains through the porous earth, and nothing is left but hot white sands and charred sticks.

The value of underbrush is underrated. Although it smothers young trees it is indispensable in forests of larger growth. The amount of mineral matter which a tree absorbs from the soil is insignificant. Water is the essential element. In checking evaporation and retarding the flow of water natural litter and undergrowth are necessary. But the smaller amount of dead wood in a forest the better, since it breeds many kinds of insects some of which may invade the living trees. The material resulting from decay however enriches the soil, so it is better to burn all the dead materials which cannot be utilized. In that way the soil is enriched just the same, the insects are disposed of, and the underbrush is not seriously disturbed. It is easy to see, how therefore, fire in a forest is often useful if wholly under control and directed by a forester. Nature with half a chance heals all wounds, and soon after a fire fresh young underbrush springs up from the roots. This tender herbage is relished by deer.

Many animals are killed by fire. Let us wander to-day through the woods of south Jersey and the only sounds are the doleful cries of cheewinks and the cawing of crows. Insects and aquatic animals are apparently not affected. The eggs of birds are cooked in nests and old woodmen tell how turtles, snakes, rabbits and the like are chased together before a raging fire. Many believe that insects increase, owing to the destruction of their enemies. There can be no doubt that flies and mosquitos are plentiful enough, and during the past season insects injurious to crops have been unusually abundant. Preserve the forest and you preserve the animals dependent upon its fruits. Our game laws are worthless so long as forest fires rage.

It is to be hoped that the general government will set aside many tracts of guarded land. A few acres showing the nature of the country in the wild state will be more appreciated in years to come than at the present time. There the trees may be properly cared for, there remarkable and unusual plants may escape the hands of thoughtless people, greedy botanists included, and there the wild animals may find a refuge and breeding place. But to bring about these changes public interest must be aroused. The people in general must unite and do their part in fostering forest regulation. At present, therefore, it is mainly a matter of education. And just here let us consider the methods and efforts up to date to check the ravages of fire. The owner of the land, if he happens to be near, picks up a few men and hastens to fight it. If the fire has gained headway he is often powerless. If by a change of wind it shifts to another man's property, he draws a freer breath and no longer concerns himself about it. In the heat and smoke men are soon exhausted and often receive little or no recompense. Unskilled persons are picked up, and often the whiskey with which the land owner lures his fighters disables others. Thus more damage than good is done. It requires bravery, skill and an accurate knowledge of the region to stop a fire. By back-firing in improper places fires have often gained in strength. The process of "back-firing" when practiced intelligently is to go some distance ahead of a fire, if possible to a road, and then burn carefully toward the fire. With the aid of sand, the handiest and best material in south Jersey for the purpose, the body of the fire may be diverted and, if not too severe, extinguished. Many will fight fire only at night so that during the day it gains much headway. It is accepted usually as a matter of course, being regarded by the majority of backwoodsmen as a necessary evil.

Roads are excellent points of vantage, and if properly trimmed are generally sufficient to check a fire. One often reads how they jump full half a mile, and how they run at the speed of a galloping horse. If the wind blows sparks are carried long distances. Fires have thus "jumped" our widest rivers. They move at a rapid rate, create a strong draft, and roar like the ocean. In ordinary fires, however, the kind which burn slowly for many days and receive little attention but do much damage, if properly managed at the proper time, a road or a stream or often even a spur of swamp is sufficient to check their headway. It is therefore necessary, first of all, that the overseers keep the brush from the sides of the road. Some progressive wood-owners have divided their wood-land into compartments and have carefully cut a belt or firebreak around each division. In that way a cedar swamp can be easily protected.

A law has been recently passed in New Jersey providing a fire marshal and deputy in every township of the third and fourth class counties. He has full control of the fires of his district. On a high location, with the aid of a telescope, he can see over almost any township in south Jersey. These stations can be easily connected by telephone, so that information can be sent from place to place without a particle of difficulty. Each marshal is empowered to employ able assistants when necessary. If the law is enforced and every marshal does his duty every fire can be nipped in the bud.

There has been a lack of interest and unity on the part of the owners of wood-land. This has led to the formation of a woodmen's association with the following objects in view:

(1) To improve and protect the forests of the southern counties of New Jersey.

(2) To prevent all wanton and needless destruction of forests.

(3) To insist upon the enforcement of the laws in relation to forests and the punishment of malicious and careless fire-setters.

(4) To adopt such methods of cutting as will increase and prolong the yield of timber and cordwood.

(5) To encourage the planting and seeding of valuable trees on Jersey waste-land, and elsewhere wherever practicable.

(6) And to encourage such methods of forest management as will tend to conserve and increase our water-supply and protect the wild animals of the woods.

It is to be hoped that every state where fires occur will appoint men to act as marshals, and that incendiaries be ferreted out and severely punished. Thus with a more general idea of forestry principles, with associations and periodicals for the dissemination of knowledge on the subject, forest fires can be stopped. Pennsylvania, New York, and especially Maine and New Hampshire, the charm of whose forest-clad mountains means more in dollars and cents than the sum of all other revenues, by much persuasion and argument have been aroused, and the majority of their intelligent people are convinced that trees are indeed worthy of judicious utilization,—that a growth of a hundred years is too precious to burn in as many minutes by a fire from the match of a careless hunter or infernal incendiary. If each state does its share the Forestry Division of the general government will be more than willing to advise and help wherever possible. It is the duty of every citizen to learn the rudiments of forestry, and every boy and girl should be taught to glory in the privilege of an Arbor day.

THE LAND OF THE MIKADO.

By J. Castell Hopkins.

JAPAN is perhaps the most interesting country in the world. After being wrapped in feudalism for centuries and hidden from the nations in a sleep of ignorance and superstition, it was suddenly touched by the electricity of modern progress, and in less than thirty years changed from a condition resembling that of the middle ages in Europe to one which places it on a par with the most advanced nations of to-day.

Little appears to be known of its ancient history. Some six centuries before the Christian era, it was ruled by a great warrior who is said to have been at the head of a Mongol or Chinese invasion and who was the founder of the Mikado dynasty which has held sway in Japan from that time to this. But the regal function gradually lost power and prestige in the Mikado's descendants, being swallowed up to a great degree in the spiritual or religious title. From the beginning of the sixteenth century the Tycoon or secular and military chief of the country assumed almost the whole actual power, the Mikado being a sort of invisible and greatly revered descendant of the gods and their inspired representative on earth. It was at this time that Tayko-Sama rose into fame as the chief warrior and statesman in Japanese annals. He was a man of mean extraction who worked his way up to the practical sovereignty of the country, reduced the authority of the Mikado to a mere shadow, compelled the obedience of the innumerable princes and nobles of the period, and after leading them victorious into Corea, died at the head of an army with which he had intended to invade China.

During the middle of the sixteenth century, Japan was first introduced to the knowledge of Europe by some Portuguese navigators, and not long afterwards, St. Francis Xavier with a number of Jesuits sought out the new and strange land and before long had established a flourishing mission. The whole empire seemed on the verge of conversion ; proselytes poured into the fold ; and the missionaries soon became so strong as to appear threatening in the eyes of the rulers. The result was a sudden change from toleration to the most intense persecution. Torture and death were the fate of all converts, and in 1860 when Europeans once more entered the country it could be fairly said that Christianity was extinct. For brief and fluctuating intervals after this period the Portuguese, the Dutch and finally the Russians, managed to carry on a little trade and intercourse with the people. But it was never very important, and the whole nation continued to manifest a most bitter antipathy to foreigners until the expedition of Commodore Perry, U. S. N., in 1852–54; the Earl of Elgin's mission in 1857–59; the resulting treaties and their gradual enforcement, compelled them to conceal the sentiment of hatred which was undoubtedly still felt. The complete and almost inexplicable revolution of 1868 which followed, brought the country at a bound into at least a close resemblance to western government and civilization, changed the system of centuries, abolished institutions which dated from before Nero or Julius Cæsar, and seemed to alter the very disposition and character of the nation.

Up to that time the country was very much like Germany in the days of Luther. The Mikado might be almost termed a Japanese pope; the Tycoon was the secular ruler; the Daimos were the feudal princes; the Saimos constituted the feudal nobility; while the military caste or following which each chief possessed, preyed upon the common people in much the same way as had been done in the sixteenth century by the feudal soldiery of Germany, France and England. But of course, the extraordinary feature is that this condition of affairs should have existed through many centuries in Japan and have lasted up to within a quarter of a century of the present time. The system was not given up however without a struggle; both vindictive and bloody. The principles of modern progress had to encounter a political economy absolutely opposed to external trade of any sort; a religious intolerance founded upon fear of outside influence, and a rampant feudalism which made treaties worthless and national honor not even a name.

Each of the two American treaties cost the reigning Tycoon his life. He felt, it now appears, compelled in each case to sign them although he knew enforcement upon such princes as those of Mito, Satsuma, Kaga and other districts, to be impossible. Death by poison followed and even the Regent, who in 1858 had something to do with the foreigners, was murdered at his palace gates and his head carried to Miako, the Mikado's capital, and there exposed with the inscription: "This is the head of a traitor who has violated the most sacred laws of Japan." But after a period of lawless disregard for treaties, the lives of foreigners, and the rights of foreign flags, Great Britain in 1864 bombarded Kagosima, the principal port, and the other powers joined in several naval displays which finally compelled a sort of unwilling and uncertain respect.

During this very time, however, the volcanic action must have been preparing, which in a few years was to cast off with lightning rapidity the garments of medieval institutions, the power of a ceremonious and superstitious priesthood, the influence of an invisible and infallible head, the authority of sanguinary and uncontrollable chiefs, the government of crafty and faithless leaders. How it was done is not known to this day. The great revolution does not seem to have had its great leader. No master-mind appears as having directed the masses and controlled the classes. Yet in 1868 a coalition of turbulent nobles and princes united in offering to consolidate the Mikado's power by yielding up to him their feudal and immemorial rights and revenues. A body of men who had instigated or allowed the murder of foreigners and attacks upon British and other consulates, issued a manifesto declaring that their object was "to enable their country to take its place with the other countries of the world." The bitter opponents of external trade and foreign intercourse overthrew the Tycoon and his whole elaborate system of commercial monopoly. The Mikado, after having passed a life of enervating idleness, luxury, debauchery and absolute seclusion, came suddenly to the front, assumed his place as the secular as well as the sacred head of the nation, clothed himself in European garments, went out into the light of day to be seen by all his subjects, and commenced the task of receiving addresses, opening public undertakings, and representing the empire in the eyes of the world, as if he had all his life been a constitutional monarch, grafted upon an eastern despotism.

It was the most marvelous, interesting, and peculiar episode in the political history of the world. There has been nothing to compare with it anywhere. All the ancient landmarks of Japanese policy, statecraft and administration were thrown down as if by one of those volcanic shocks for which the islands are famous. They were replaced within half-a-dozen years by elements of western civilization and government which have elsewhere been the product of centuries of slow and stormy development. Old and new were commingled, and forty millions of people of Asiatic stock dropped almost in a moment from the feudalism of a thousand years into a system of modern monarchical government with a gradual but steady approximation towards the "popular" government of the present moment. It was in the strange realization of the fact that these latter institutions could not be had all in a year that we recognize a quality in the people, equal to that hitherto unrecognizable one in the four thousand nobles of the country who had a short time before voluntarily thrown off their mantles of despotic local power.

The government was formed around the time-honored authority of the Mikado, who solemnly engaged himself to rule in conformity with the will of the people. But no means were given him of ascertaining those wishes until later on, when it was decided that in the year 1890 a parliament of the nation should be called and a representative constitution formed. It was thought that in the interval the people would be educated up to the ideal. Meantime his majesty was to govern by the advice of a council of state, composed of one prominent man from each of the chief provinces, the prime minister, the vice-premier, and the heads of the several departments of the government. The edicts of this council were to be the law of the land. Development went on thenceforward at almost railway speed. In 1872 a law was proclaimed which provided for the establishment of 53,000 schools or one for every 600 of the inhabitants. A naval college was organized under the instruction of foreign officers; railways were started in several directions; foreigners were everywhere made welcome; strict honesty and honor were shown in all international engagements, and especially in monetary matters. In 1876 an Industrial Exhibition was held and in the succeeding year it was announced that there were 3744 post offices established. In 1884, a new order of hereditary nobility was instituted, the national religion disestablished, the sacred character of the Mikado done away with, all Japan thrown open to foreign trade, and entire freedom of religion granted.

During the next few years, Prince Komatsu, the heir to the throne, visited England and conferred upon the Queen the chief Japanese order of knighthood; Count Ito, the prime minister, introduced a vigorous campaign in favor of western dress and habits; the Bible was translated into Japanese; and a commission went abroad to study the fine arts in Europe and America. Its decision was in favor of Japan: "Pure art is asleep in Japan, but dead in Europe." In 1890, the first free parliament of the empire was opened by the Mikado, or emperor, as he is now styled, in person. It was composed of a house of peers, somewhat after the English model, with ten life members, 139 elected nobles, 59 imperial nominees, and 44 elected men of mark; and a house of representatives having 300 members—all elected. The first president of the upper house and the leading man through the succeeding and inevitable mutations of politics was the Count Ito, already mentioned.

Thus started upon the high road of progressive civilization, the Japanese have come to think themselves the leading power in Asia, the most intelligent people in the world, and have, naturally enough, fallen into the present war, and proposed the abrogation of the international treaties which in latter years have been so unjust and oppressive in view of the entire change of national conditions. One of the best humorous and satirical sketches I have seen of this rapid march of civilization in Japan, and its present effort to sustain an historic policy of acquisition in Corea, is the following from the London *Punch:*

(*From a Record in the Far East.*)

Step One.—The nation takes to learning the English language.

Step Two.—Having learned the English language, the nation begins to read British newspapers.

Step Three.—Having mastered the meaning of the leaders, the nation starts a parliament.

Step Four.—Having got a parliament, the nation establishes school boards, railways, stock brokers, and penny ices.

Step Five.—Having become fairly civilized, the nation takes up art and commerce.

Step Six.—Having realized considerable wealth, the nation purchases any amount of ironclads, heavy ordnance, and ammunition.

Step Seven.—Having the means within reach, the nation indulges in a terrific war.

Step Eight and Last.—Having lost everything, the nation returns with a sigh of relief to old-fashioned barbarism.

But whatever may be the result of this conflict in the East, it cannot involve the complete subjugation of the Japanese. The people are too bright, clever, and powerful in imitation, to be permanently beaten by a slow-going, though mighty mass, such as the Chinese empire. They are wonderfully intelligent. Japanese workmen constructed and worked a steamboat some time before an American or European steamer had appeared on their shores. Long before foreign influence was felt in the land, the libraries of Meako and Yeddo contained as many as 150,000 volumes, and universities were established at both places as well as at Nagasaki. Printing was introduced from China in the thirteenth century, and reading has long been a popular amusement. In the days of feudalism the Japanese knew enough of mathematics to make good maps, and to measure their mountains with a barometer. In the carving of ivory and working of wood they have had few equals. Their skill in making mechanical things, such as toys, tops, etc., is marvelous. Travelers speak of the throwing of tops like a boomerang which return to the thrower, and will spin and continue to spin in all sorts of places and ways for a seemingly interminable period.

Generally speaking the empire of Japan is supposed to consist of three large islands—Niphon, Kin-so and Sikok—but around these are several thousand small ones which have been acquired from time to time. The climate is delightful, the cities numerous and populous, and the chief occupation up to very recent years has been agriculture. The complexion of the Japanese is yellowish, with a brown tinge ; the eyes small and not so much sunk in the head as the Chinese ; the hair is black, straight and coarse. Their costume is peculiar and voluminous, both sexes wearing very similar clothes. After marriage the women disfigure themselves hopelessly by blacking their teeth and pulling out their eye-brows. Before marriage they are as a rule very graceful in appearance and often exceedingly pretty. So far as the origin of the people can be traced they seem to be the result of a mixture of Chinese and Malays, the former settling amongst the others much as the Normans did in England of old.

It is a land of paradoxes and anomalies. Thirty years ago everything seemed to Sir Rutherford Alcock, the British minister who spent three years of danger in the country, to be in reversed order. The people wrote from top to bottom, from right to left, in perpendicular instead of horizontal lines, while their books began where ours end. Their locks, though imitated from Europe, were all made to lock by turning the key from right to left. The old men flew kites while the children looked on ; the carpenter used his plane by drawing it to him ; the tailors stitched from them ; the horses were mounted from the off side and stood in the stables with their heads where we would place their tails. The ladies blacked their teeth instead of keeping them white, and then as now, the sexes mixed freely in public bath-houses without a thought of immodesty, but piled on clothing when they went into the street. And to-day the natural habits of the people are in constant and amusing contrast with the national and western ideas of the time.

They are, as already stated, wonderfully adept at imitation, and if at all possible will never allow a foreigner to excel in anything. Indeed the only possible explanation of the great revolution is that the nobles saw the superiority of the foreign systems and practices and made a sudden resolve not to let that superiority be felt or known. In the early days of the English legation a lacquer-ware man was given some spurs, curb-chains and stereoscope cases for repair, and finally a lock was given him to fix on a box. He had never seen such things before, but some time after the necessary work had been done it was discovered by the merest accident that many of the articles returned were counterfeits and the lock and key imitations ! Cork-screws, glass-shades and other things were easily and quickly copied.

Another curious feature in their character which seems to have largely disappeared under new conditions was the tendency to act as spies and the entire absence of any consideration of dishonor in such a position. Everybody from the Tycoon down was watched and watched some one else in turn. When the Earl of Elgin and Kincardine arrived upon his mission they could not understand who was watching him ! No one in his suite seemed to have note-books for that particular purpose and there was certainly no one specially appointed, as would have been the case with them. So, seeing the double name in his signature, the conclusion was come to that the Kincardine who seemed to be nowhere visible, was in some way "keeping his eye on Elgin."

It would be hard to say just what the present religion of the Japanese is. There are all kinds of sects, Buddhism probably predominating. Since the Mikado renounced his infallible and sacred character considerable looseness in religious thought or superstition prevails—leaving, of course, all the more room for the advance of Christianity. The temples are very simple structures, the chief internal feature in many of them being a looking-glass, supposed to be emblematic of the soul's purity. Near it is a font containing water. In this the worshipper washes, then proceeds to the looking-glass and prays for what he wants, and after leaving a few coppers in a box near by, rings a bell at the door thrice as he goes out.

The wealth and strength of Japan is now very considerable. There are 5,000,000 families who own land in small quantities and farm it to fair advantage. The exports which amounted to $3,600,000 in 1861 were valued at $91,178,000 in 1892, and the imports have risen from $2,240,000 to $75,900,000. The bulk of what the empire buys comes from England, the bulk of what it sells comes to the United States. Its public debt is $267,000,000 and the national credit has been exceedingly good since the country opened its ports to foreigners and sought to rival them in the freedom of its institutions and the advancement of its civilization. It spends nearly nine millions a year on the navy and twelve and a half millions on the army, one million on education and nearly four millions on police. It possesses five armored ships, seven protected cruisers, 12,000 seamen and 245,000 soldiers.

In material affairs the progress of the Mikado's realm has been marvelous. The activity, powers of imitation and natural cleverness of the people, have asserted themselves as clearly in commercial and industrial progress as in political development. In 1872 the first line of railway was opened from Tokio to Yokohama, a distance of 18 miles. In 1893 there were 1864 miles of railway, used during the year by 25,000,000 people. Of these 551 miles were owned, and carefully managed, by the government. The foreign trade of 1892 was double that of 1884, whilst the internal trade in silk-worm eggs and cocoons and in camphor, copper, and similar products, is steadily growing, partly as a result of railways and partly because of the good roads with which the islands are now covered as by a net-work.

In certain lines of cotton-goods the Japanese now compete throughout the far east with British goods, and the excellence of their manufactures is steadily increasing. Still, 82 per cent. of their foreign trade is in foreign hands and controlled under treaties made twenty years ago and entirely out of harmony with existing conditions. In 1892 the country exported five millions worth of gold and fifteen millions of silver; possessed 1,546,000 horses and 1,044,000 cattle; produced 90,000,000 bushels of rye, wheat and rice, and grew 55,000,000 pounds of tea.

Business methods and institutions in the England of the east are very similar to those upon this continent. In 1878 the first chamber of commerce was started. Now there are fifty of them, together with 2013 trades unions; 13 rice exchanges; three stock exchanges; three general exchanges, and 134 national banks. The Bank of Japan is a well-managed and stable institution with large capital. Then there are 2631 joint-stock companies and 2489 factories of which one-third are run by steam-power. Of the 767 serial publications, 167 are devoted to agriculture and about the same number to science. Besides the universities elsewhere referred to, there are five government technical schools equal to the best in European countries. It is little wonder, in view of such a twenty year record, that China is having the worst of the contest with her vigorous and clever antagonist!

The empire may therefore be said to have fairly established itself and the people to have earned the reputation of being the most remarkable nation in Asia. What may be ahead of them in the way of development or misfortune no one can predict, but whatever it is they have given to Asia a beacon-light of civilization from which much should be learned. Within twenty-five years they have achieved what European peoples have taken centuries to do. The monarch has thrown away his imperial robe of seclusion and the halo of religious veneration which were his by right of 2000 years of precedent and power. The feudal system and oppressive oligarchy have been swept away in favor of a free government and a foreign scheme of rule. The once hated foreigners are given ample freedom, welcome, and even employment. Where the shores once bristled with dangers to navigation, light-houses are now everywhere established. In the capital where the British minister twice nearly lost his life, twelve foreign powers are now represented. Where the highway of Yeddo once threatened him with death, the foreigner now rides his bicycle, with the whistle of the locomotive in the distance, and the sound of the telegraph operator at given intervals.

Well, therefore, have the Japanese earned the right to call themselves a progressive people and to speak of "new Japan; the land of the Rising Sun." And whether right or wrong in the present war; whether finally victorious or defeated, we cannot but hope that they may remain a light in the eastern sky until the day of a final and better dispensation dawns upon the nations of Asia.

THE USE OF TERRA-COTTA IN MODERN BUILDINGS.

By George M. R. Twose.

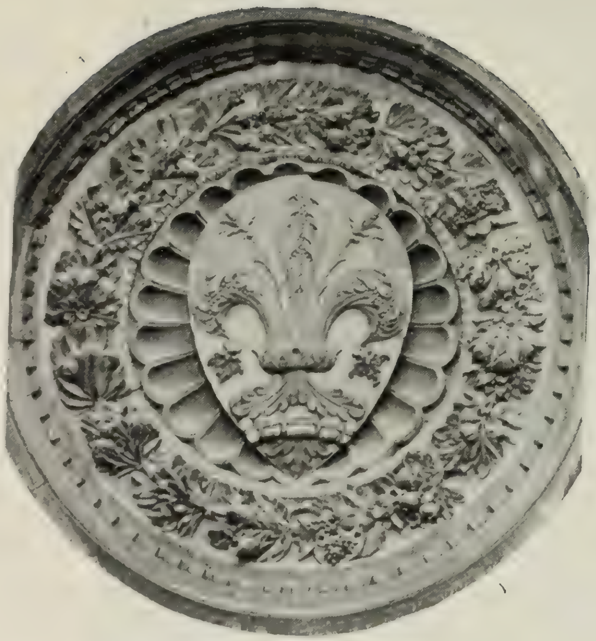
EVERY reader of the periodical literature of the day, especially the technical journals, is familiar with the individual who occasionally appears in the correspondence column with a brand-new answer to his own conundrum, "What is the age in which we live?" This individual, anxious lest the period should pass unchristened into the irretrievable past, is fond of informing us that the world has at various times been distinguished by an Age of Stone, an Age of Iron, and an Age of Bronze, and he frantically urges his generation to devise some title by which these days also may be identified in future eras. The gentleman in question is generally supposed to be brother to that other intelligent person who fiercely demands of architects "Why don't you invent a new style?"

We have dug up past and forgotten ages from oblivion and laid them, carefully cleaned and labeled, on the museum shelf. That task was comparatively simple as compared to the one awaiting those who are to dig us up, restore and ticket our frame houses, apartment-houses, and office-buildings, trace the germ through its development, and probably haggle over the precise number of æons that must have elapsed ere the primitive wooden structure bloomed and blossomed into the stately steel-ribbed "sky-scraper." The mound-builders were faithful to the simple traditions of that system of construction long enough for it to become nationally characteristic; the cliff-dwellers displayed no new and wanton fancies in successive decades with regard to the appearance of their dwellings, but the sons lived as did the fathers, and left no complicated question of architectural development for us to unravel, though it must be admitted they provided abundant food for surmise in other directions. So, too, we know the ancient Egyptian through his pyramids. But by what will Macaulay's New Zealander know us?

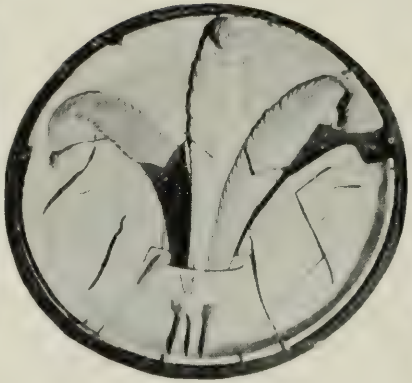
In the architecture of the present day no single material has remained the medium of expression for a length of time sufficient for the development of any individuality founded on the character of its builders, local circumstances, or popular ideas; and the architectural history of every spot—Chicago for instance—is a record of continuous change. The frame house endured for a generation and was succeeded by the edifice of red brick, which in turn succumbed to the superior attractions of the "Early '76" style of brown stone and galvanized iron. This was the herald of a medley of various-hued stones; and color having become an attraction, bricks reappear in a rivalry of motleyness; fascinating color combinations begin to absorb the attention of the architect; and then the restless energy of the day pushes into his hand a new material bidding him reject all others in its favor.

Terra-cotta as a building material is essentially a product of the age. Though its use primarily was the outcome of certain requisite conditions encountered in the erection of office-buildings, it quickly graduated from merely utilitarian duties, and is no longer confined to the construction of floor arches and the enclosing of beams. It appears in the fronts of buildings with its inherent beauties well developed, challenging attention as much for its esthetic qualities as for those more solid merits which make it one of the most valuable

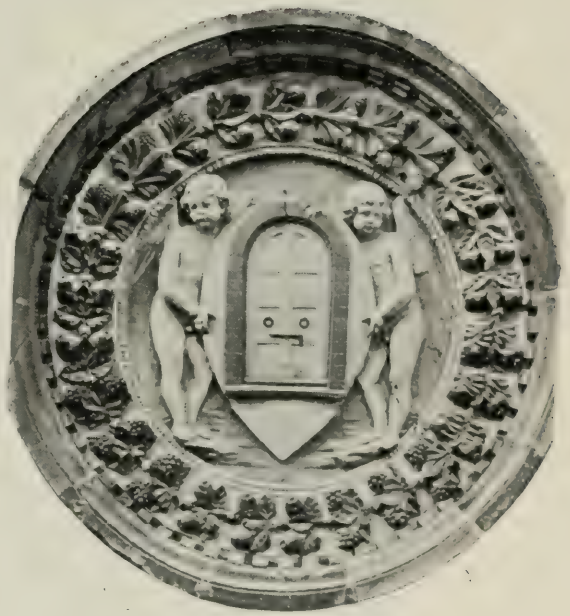
THE ASSUMPTION, AT THE CEPPO HOSPITAL, PISTORIA.
BY GIOVANNI DELLA ROBBIA.



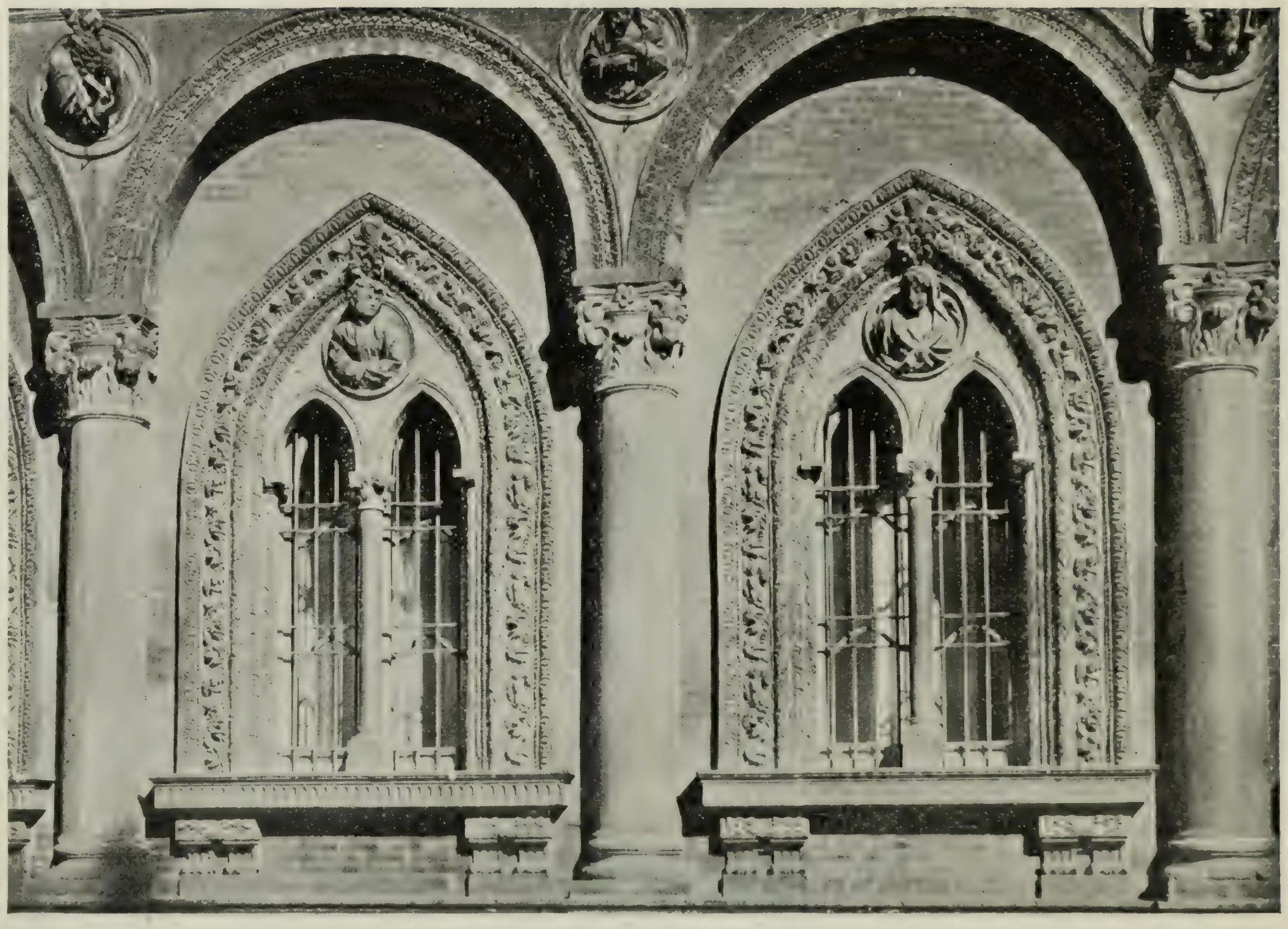
ARMS OF THE UNIVERSITY COUNCIL OF MERCHANTS, AT OR SAN MICHELE, FLORENCE.
BY LUCCA DELLA ROBBIA.



CREST OF LORENZO DI MEDICI IN THE MUSEO INDUSTRIALE, ROME.
BY LUCCA DELLA ROBBIA THE YOUNGER.



TERRA COTTA MEDALLION, SAN MICHELE.
BY LUCCA DELLA ROBBIA.

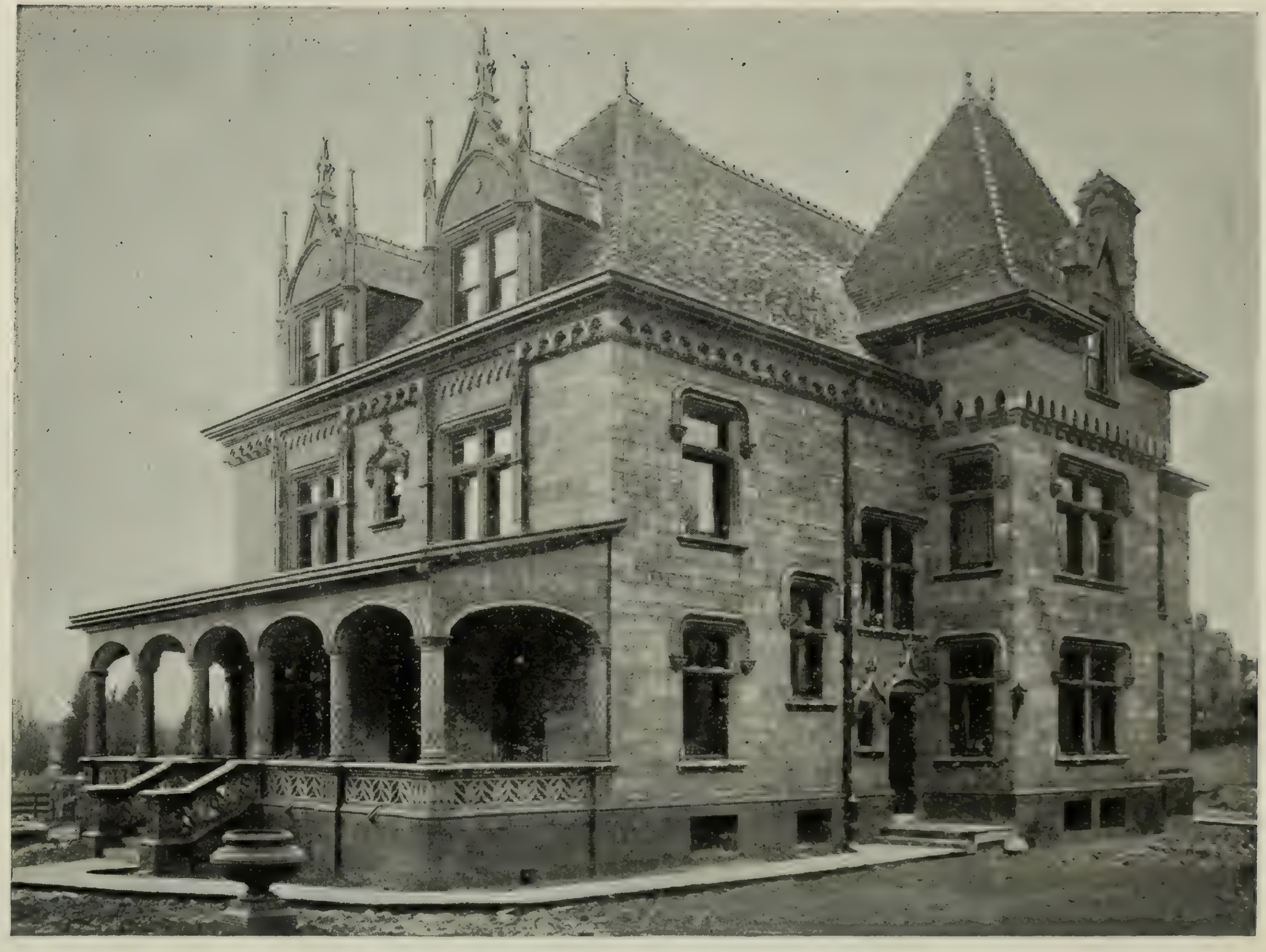


THE GREATER HOSPITAL, MILAN.

of building materials. It is, as far as its uses are concerned, a new material, the intelligent treatment of which may lead to new architectural forms, generally the result of new material and new ideas for which the critic clamors.

In any consideration of terra cotta, however, we must be careful to distinguish between the two different positions in which it is found. The conditions are so dissimilar, and the duties exacted of the material so different, that only a plastic substance like terra-cotta could adapt itself to such varied circumstances. In its ordinary architectural use, as in string-courses, sills, copings, panels, or as the entire walling, terra-cotta occupies an entirely different position and performs work entirely different from that demanded of it when, in conjunction with steel, it helps to rear a modern office-building. It is then the substitute for the heavy masses of brick-work which a few years ago were the exterior fireproofing material. Certain advantages which it possesses over brick-work (in addition to superior fireproof qualities), such as great comparative lightness, adaptability to every position and form, great responsiveness to artistic thought, and the possibility of its manufacture in blocks convenient for handling and setting with great speed, make terra-cotta the material *par excellence* for use in this connection. In its possession of necessary strength with a minimum of weight, ability to conform strictly to the structural necessities of another material, richness of color and great capability for magnificence of effect, terra-cotta is an almost perfect symbol of the convenience and luxury on an economic basis which distinguish the great buildings in which it is thus used.

When first experimentally introduced terra-cotta was regarded very largely as an imitation stone, a material with which it was possible to include in design the decorated surface, the cusp, the quirk, the crocket, and the finial, hitherto forbidden by the great cost of such work in stone. In the desire to make the utmost use of this plastic quality, which is at the same time the great strength and the great weakness of terra-cotta, the greater possibilities of an individual development were overlooked. All discrimination of material was lost sight of in the eagerness with which architects applied themselves to producing with its aid erections, which, lacking in due recognition of material, can only be classed as elaborate pieces of mimic masonry. Used as a component in legitimate masonry construction, terra-cotta suffers very largely even to-day from this misunderstanding of its nature, and this is most clearly demonstrated by the fact that nearly every building in which it has been used exclusively would look a good deal better if executed in stone. The inferential conclusion is that the designer of each such building must have thought in stone and de-



A TERRA-COTTA RESIDENCE IN IMITATION OF STONE.

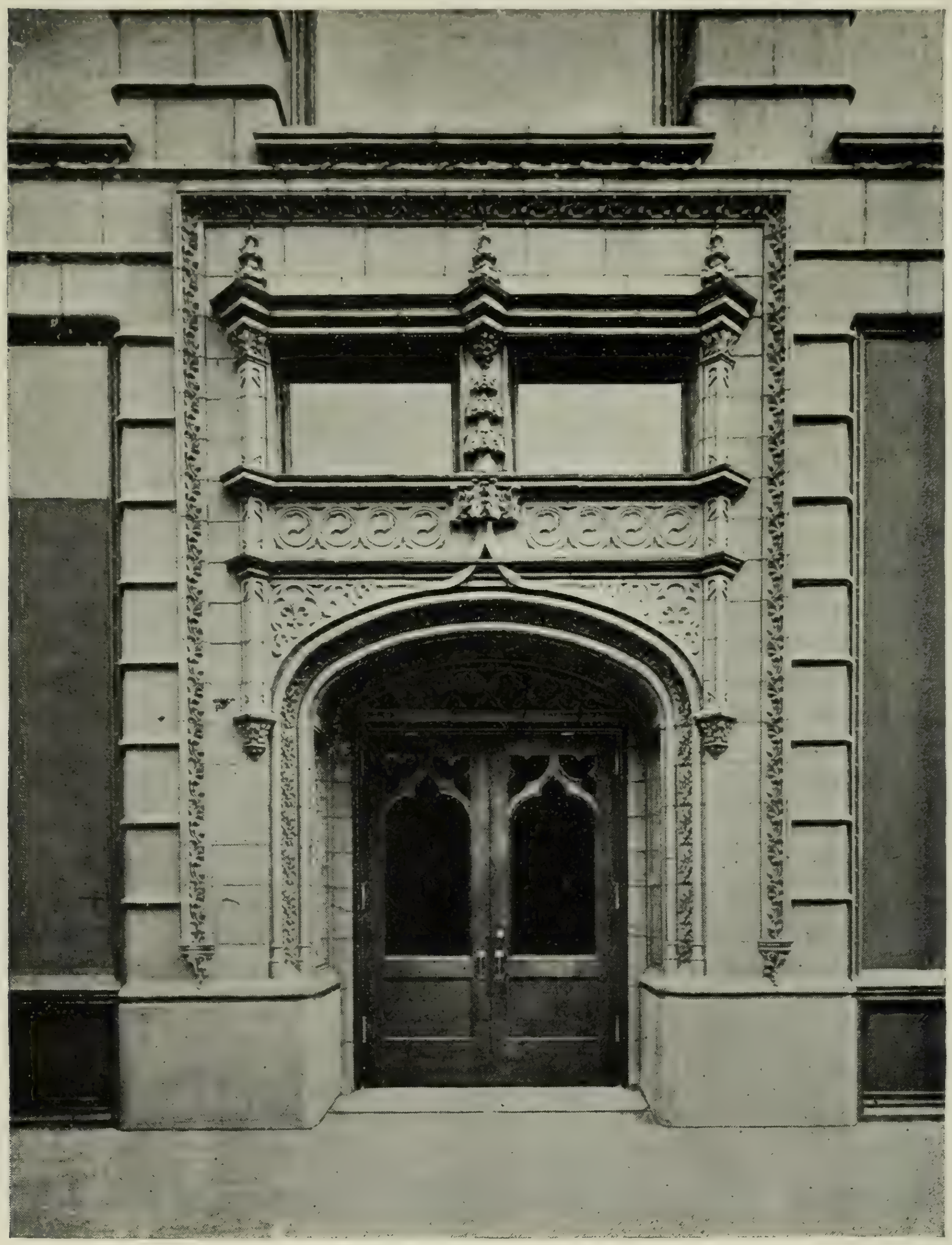
"Every building in which terra-cotta has been used exclusively would look better if executed in stone."

signed in stone, and that terra-cotta possessed for him no individuality sufficiently strong to compel a recognition and impress the result with its characteristics. We have yet to appreciate the distinction between terra-cotta as a material *sui generis* and terra-cotta as an imitation stone.

Architectural problems hitherto have been solved by means of stone, or brick, or wood, and in so far as the design was properly related to the material and the idea to be expressed, so far was the result a successful one; and the greater of these results are the standards of to-day. Omitting the strong tendency to centralization which has created certain new problems that have been successfully met by the use of steel, the demands made by present civilization upon architectural construction are substantially those which have been made during past ages; but we have in terra-cotta a new material with which to solve them. The question as to how far that material has an individuality of its own, and how far it should assume the characteristics of another, is an interesting one.

Used in blocks similar to ordinary stone-ashlar, terra-cotta produces a wall whose strength, like that of a stone or brick wall, lies in the combination of the units composing it. But as brick architecture is essentially different from stone architecture, on account of the different natures of their component units, so work in terra-cotta may be expected to develop an individuality of its own in so far as the peculiarities of its composition and manufacture distinguish it from other building materials. While having the strength of brick-work, the different nature and size of the terra-cotta blocks demand a different disposition from that which we have learned to be the best for bricks. Again, a modification of certain constructive portions is the immediate natural outcome of the dissimilarity existing between terra-cotta and stone ; in spanning openings, for instance, when terra-cotta trabeation is forbidden by the tensile strength of the material, a similar construction to the straight arch in brick-work being the alternative ; or in arches when the hollow terra-cotta blocks used constructively require a greater length of voussoir than does the solid cube used by the mason.

Examples of the differentiation of the form of a weaker material used constructively may be found in the work of the late H. H. Richardson. In many cases the field of the wall is of granite while the arches (almost exaggerated in size) are of sandstone, the lower crushing resistance of the latter material furnishing the reason for the great size of the arches as compared with the granite forms. The dimensions of voussoir and other stone constructive forms are generally so much in excess of the size which mathematics requires that terra-cotta arches may often be of the same dimensions as those of granite in similar positions, and still be violating no law, the pleasing of the eye more than the observance of strict scientific construction dictating the result Yet it is evident that a fundamental demand for difference of treatment exists in the very composition of terra-cotta, and reasons multiply as we proceed.



TERRA-COTTA OR STONE —WHICH ?

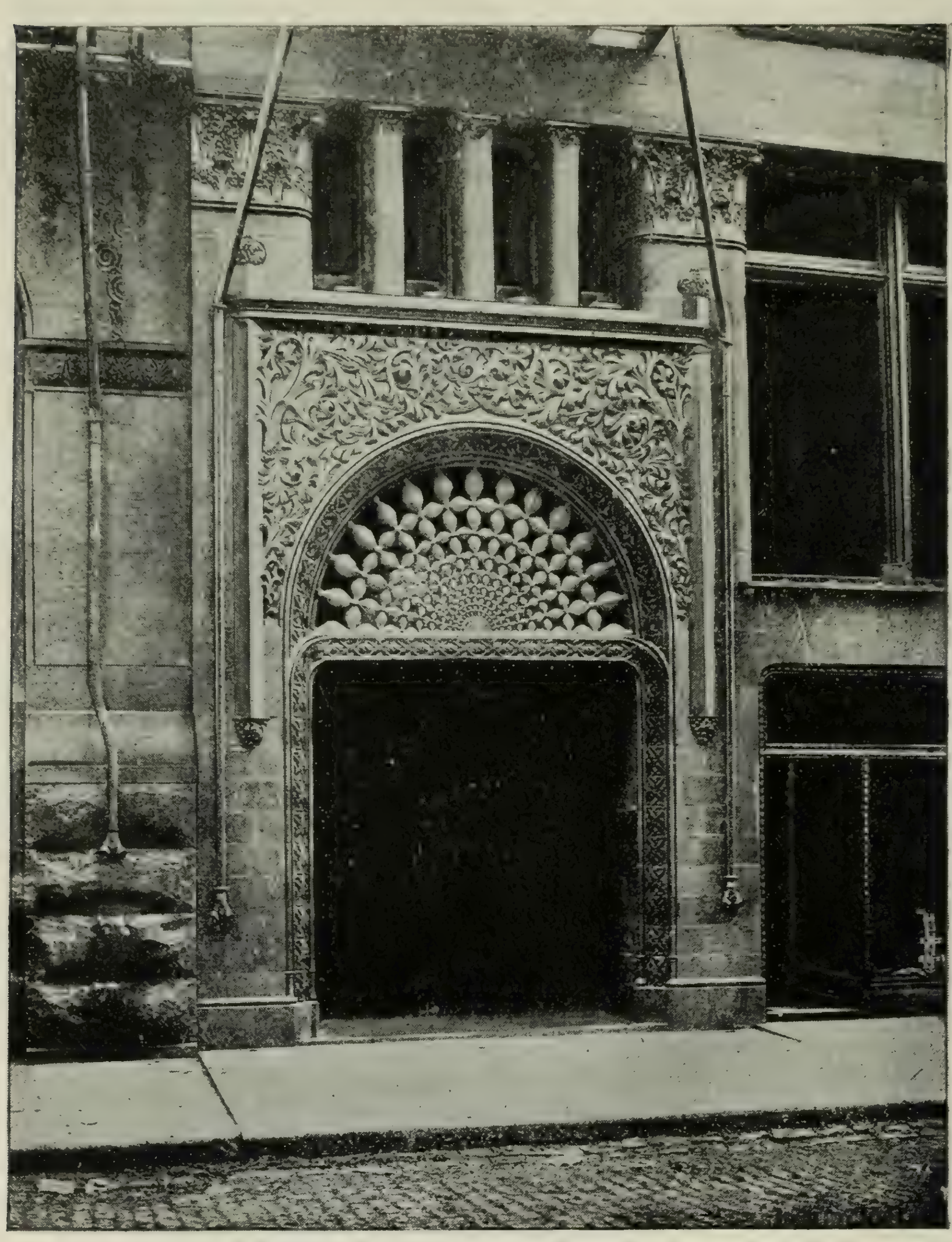
" The question as to how far terra-cotta has an individuality of its own and how far it should assume the characteristics of another material is an interesting one."

Since the economy of manufacture limits the size of the product, very large or heavy projections of single pieces in cornices and similar features are out of place in strict terra cotta work, inasmuch as they require concealed supports, and present difficulties which prevent one from regarding buildings in which such forms are incorporated as successful unions of design and material.

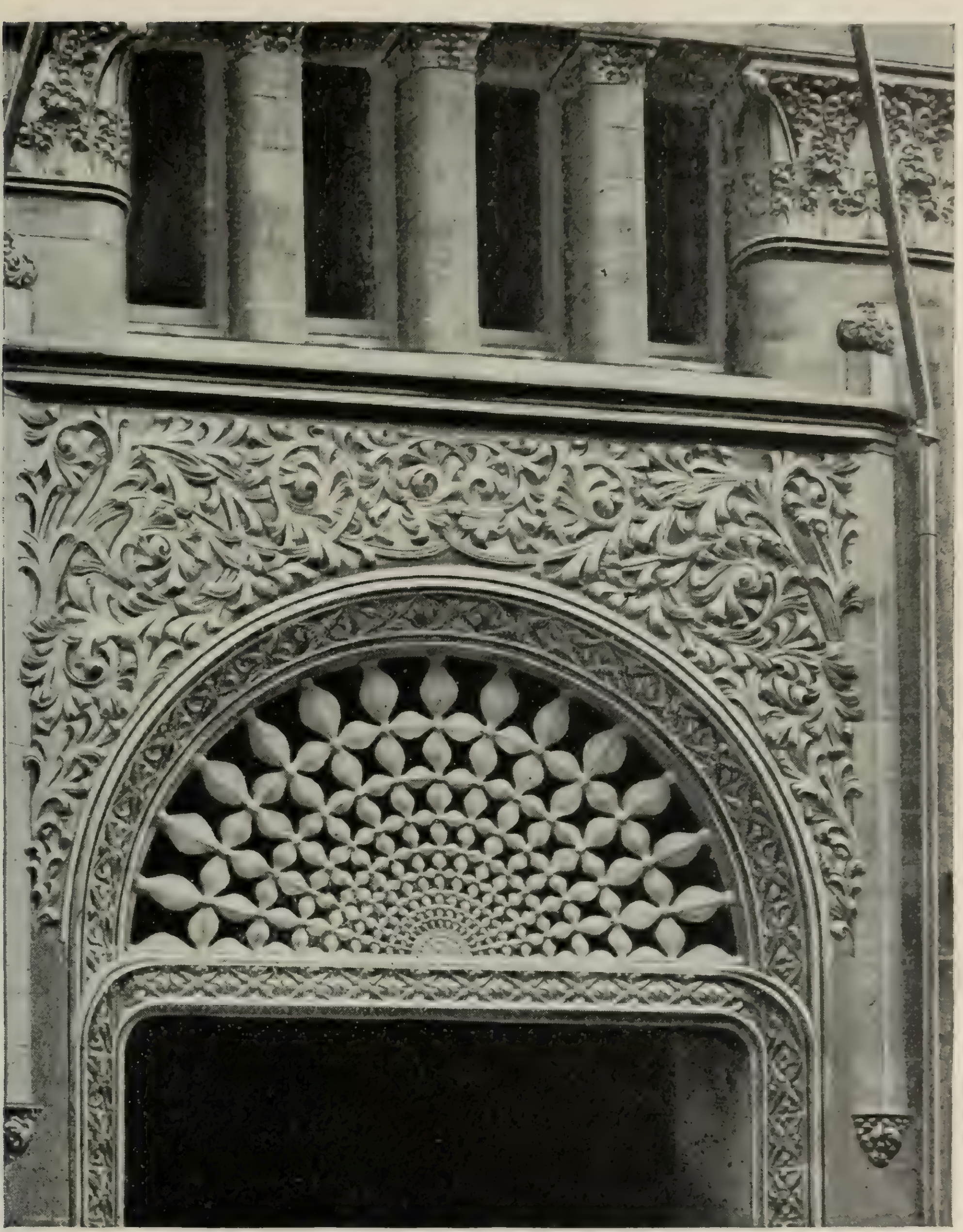
The Renaissance palaces designed by Michael Angelo and Bramante depend for much of their effect upon the magnificent cornices which crown them. These cornices are of stone, and have the great projection which the chemical conditions of the material render easy and legitimate. With the spread of this particular style of building to districts where clay is more easily procurable than stone, we do not find any attempt to reproduce in any imitative way the stone form or its projection; and yet many of the Italian towns afford examples of brick cornices which cap their building with an esthetic value equal in richness and effective-

A VASE, INDICATING THE POSSIBILITIES IN MODELLING TERRA-COTTA.

ness of light and shade to any of the stone prototypes. This was accomplished by an intelligent recognition of the limitation of brick-work and terra-cotta. By obtaining in height what was impossible in projection, by an additional richness of detail and surface and a skillful use of forms properly attainable by a combination of small units, a cornice of brick-work was created which, while similar in its effect, giving the same impression, performing the same duty, and occupying both structurally and artistically the same position as that of the



ENTRANCE, RAND-M'NALLY BUILDING, CHICAGO.



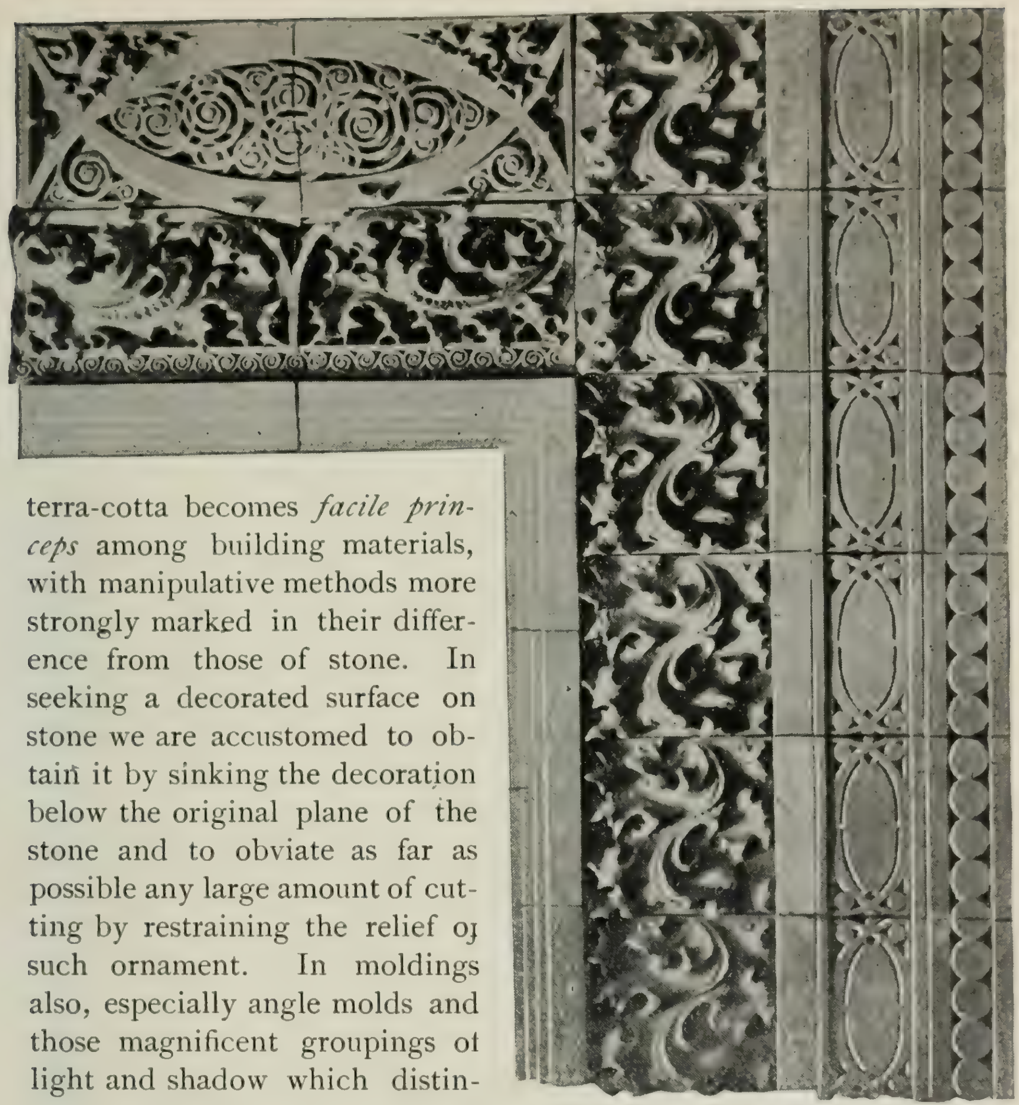
"It is in its more decorative aspect that terra-cotta becomes *facile princeps* among building materials."

stone example, was yet entirely different in composition and construction, and the manner in which the effects were obtained. This difference of treatment was merely the result of a proper appreciation of the difference existing between the two materials.

Terra-cotta occupying a medium position in point of weight, manufactured size, and color, between stone and brick, we are not likely to find in its proper use such a great distinction as exists between brick-work and masonry; for, while possessing qualities which are peculiar to itself, it at the same time partakes largely of the character of both. Omitting all consideration of what may result in the way of modeled and decorated forms from a development of its plastic qualities, the difference between terra-cotta and stone or brick would seem at present to lie in the elimination of those forms of both which are not attainable in this material,—a distinction of omission rather than one of commission.

The transom-bars, for instance, of which French domestic architecture of the fourteenth and fifteenth centuries afforded so many examples, owed the possibility of their existence to the fact that stone was obtainable in pieces of sufficient length to span the window openings, and was of sufficient density to permit its use in this respect in pieces of small section. These two qualities are not ordinarily obtained in terra-cotta, so that a copy of these transom-bars in terra-cotta is produced (as witnessed by three examples in the locality of the writer) by the employment of several pieces where, in the model, only one was used, the consequent straight joints occurring in unsupported lengths offending the eye and the sense of stability. The inference would seem to be that terra-cotta transom-bars, unless constructed in such a manner as to give a satisfactory esthetic impression, had better be omitted, and that their charm in stone architecture is not an excuse for mimicking them in another material whose aptitude for such an operation falls short of the ability to produce even a satisfactory imitation. The buttress and pinnacle, again, if used in their proper constructive spirit as members whose value to the organism of which they are a part consists of the sheer weight they oppose to certain thrusts, are forms which are beyond the range of terra-cotta construction, although well within those of brick ; a fact easily accounted for by a comparison of the average weight of a terra-cotta block and the weight of brick-work occupying a similar space. Yet terra-cotta buttresses and pinnacles are not unknown. These are but two examples of the thoughtless copying of the picturesque forms peculiar to stone that marks the present use of terra-cotta. Too many others could be enumerated if it were necessary.

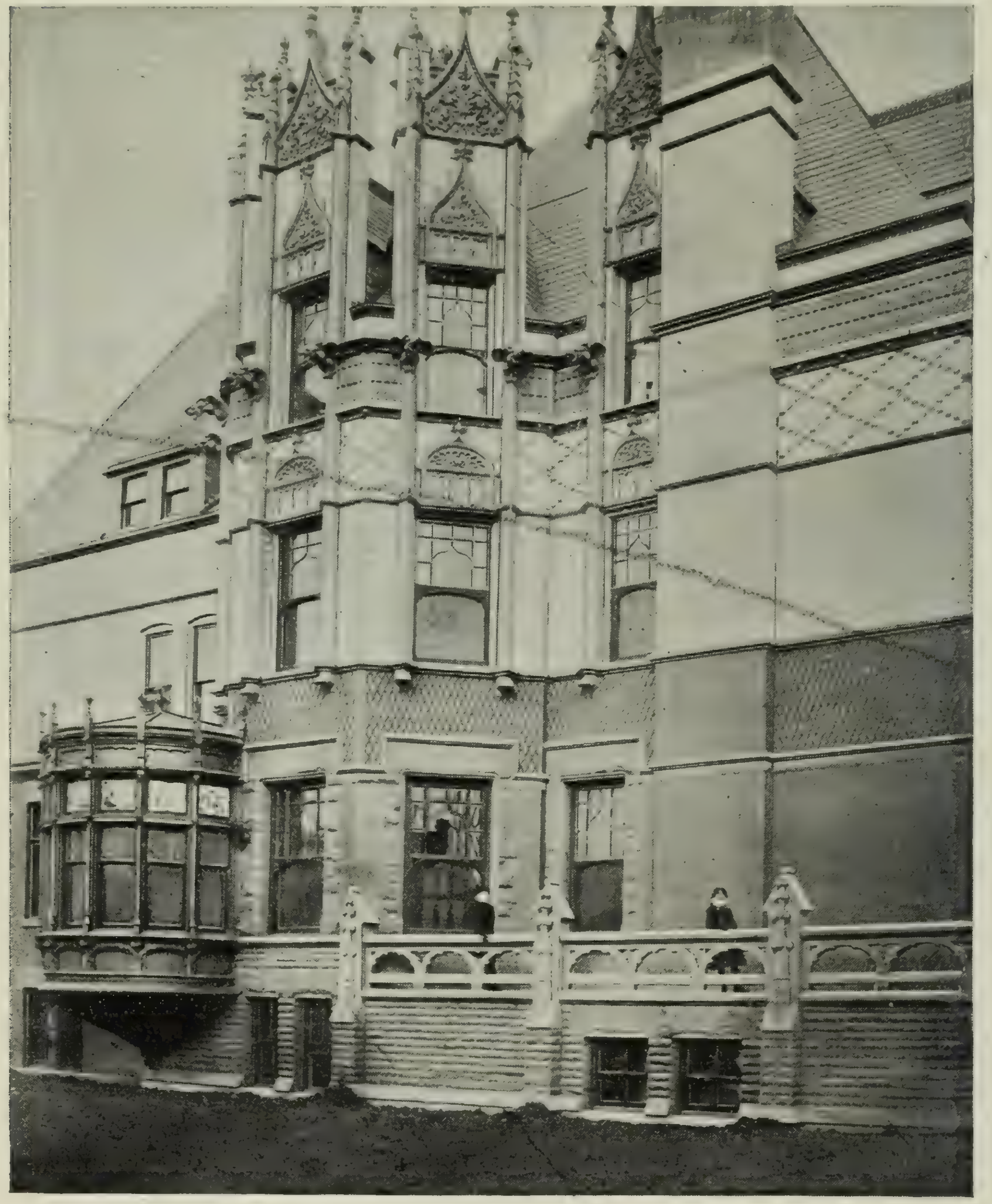
No definite line of demarcation can be drawn between terra-cotta and stone so far as general forms are concerned, any more than between brick and stone ; but the causes for omission and demands for a difference of commission which have been quoted can be multiplied to an extent which show the necessity for discrimination in dealing with terra-cotta and its right to be regarded as a distinctive material. This difference does not end with any variation of constructive laws, however, but continues through all the phases by which terra-cotta is known to the building world. It is in its more decorative aspect that



"The varieties of decorated surface."

terra-cotta becomes *facile princeps* among building materials, with manipulative methods more strongly marked in their difference from those of stone. In seeking a decorated surface on stone we are accustomed to obtain it by sinking the decoration below the original plane of the stone and to obviate as far as possible any large amount of cutting by restraining the relief of such ornament. In moldings also, especially angle molds and those magnificent groupings of light and shadow which distinguish medieval masonry, the rich effects are obtained by cutting back the hollows from the original plane. The worker in terra-cotta, however, is not confined to any one such method, since he is not confronted with a rectangular cube of stern uncompromising material but a plastic mass, easily manipulated and modeled and assuming with equal readiness any form that the mind may suggest. Relief, therefore, is not so limited, and that system of decoration known as "cameo" is as easily rendered by terra-cotta as the "intaglio" one to which stone is somewhat confined.

The massive effects of large and rock-faced stones with their appearance of vigorous crystalization are to a certain degree unattainable in terra-cotta, on account of its limitations of texture and size. Yet this is compensated for by the ease with which it is ornamented, and surface patterns of large and bold design, with deep interspaces and shadows, may be considered as the parallel in this more decorative material of the quarry faces of nature. At the other end of the scale, polish is duplicated by glaze, while between lie all the varieties of decorated surface attainable in terra-cotta with an ease which is paralleled in no other building material. Repeated ornament is especially easy to obtain, and though repetition of molded ornament is not a thing for vigorous commendation, there are occasions when it is effective as well as economical, in the emphasis of function for instance,



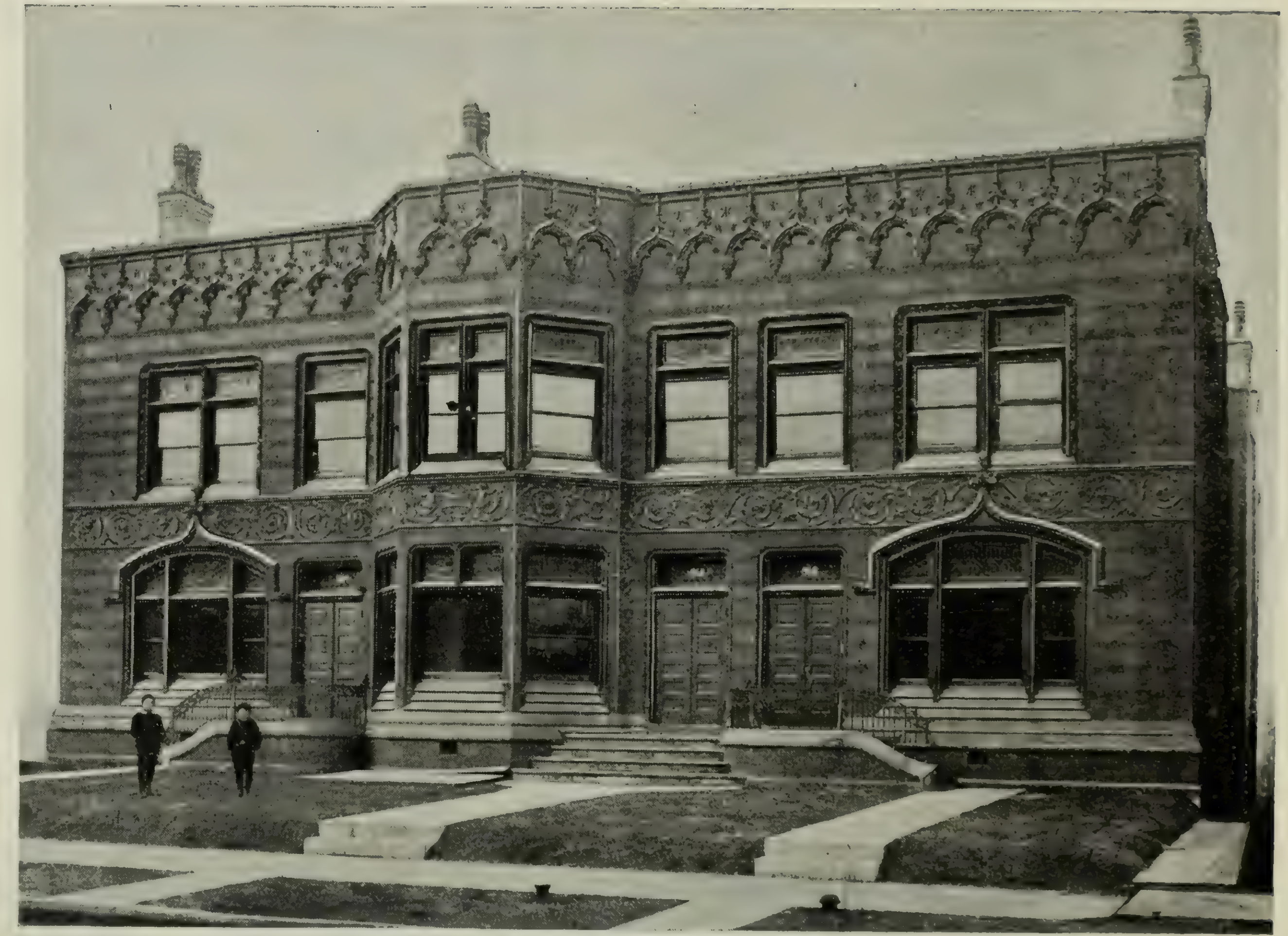
A SOUTH SIDE CHICAGO RESIDENCE—TERRA-COTTA DECORATIONS.

and we may yet see the day when the separate modeling of each piece will permit a certain difference and freedom in each repetition.

The ashlar form of terra-cotta, like the brick-work of the day, is beginning to suffer from too high a pitch of mechanical perfection, and this is very apparent where plain walling is concerned. The Cinquecento buildings of terra-cotta possess, as a rule, wall surfaces of beautiful variety of tone, arising from the different shades in the blocks and an absence of any attempt at the mechanical symmetry of color which the brick-maker and terra-cotta manufacturers of the day have set as their ideal ; the homogeneity of tone they aim at may testify to their great control over their method of manufacture, but it is done at the expense of picturesque variety and charm. In a final comparison terra-cotta possesses one great advantage over stone for its use in cities, and that is a surface which, after its baptism of fire, is capable of successfully resisting the strongest gases and acids that the foulest city air contains, and one which every shower of rain restores to its pristine freshness, washing off the tender overtones which smoke and soot so delicately spread.

It will be seen from this brief comparison that terra-cotta possesses several distinctive properties which call for their own treatment and place it in a different class and under different regulations from those guiding the use of stone. Although the fundamental architectural forms are little capable of change, the difference in broad general treatment which the material demands will, if we faithfully adapt our design to its idiosyncrasies, give to terra-cotta an architecture as distinctive in character as that based upon wood or brick or stone. It is in a consideration of the ethical character of terra-cotta that one encounters the greatest objections that are to be urged against its use, and, paradoxically, its greatest virtues are its greatest vices. In all history we find that those peoples who have had to struggle with physical conditions and earn their harvest at the expense of hard labor, have become nationally more noble and dignified, and possessed of greater activity and courage, than have those peoples who dwelt in lands where nature gave almost without the asking, destroying in her prodigality all motive of initiative and action. It is the labor they demand, and the skill that has to be employed before they record the thought of the artist, that give to stone and marble the nobility and dignity they possess in architecture. Terra-cotta, however, opposes no such barrier before yielding, but, being plastic to a degree, may be said to leap forward to the modeler and, meeting him almost half-way, realizes at once the grandest and broadest conceptions with an ease equalled in no other material.

Unless the nature actuating it be one of dignity and great restraint, capable of severity and self-denial, terra-cotta in its easily-attained



"The use of terra-cotta is already spreading to domestic construction."

prettiness and its temptation to overload with ornament and indulge in sensuous display, may be regarded almost as an immoral material, and one whose unrestrained use is likely to militate in the worst way against the high and pure laws of true architecture. The very ease with which it realizes the modeler's thought, which is one of its best qualities (admitting as it does of variation and improvement in the work as he proceeds), is also a quality which tends not only to a large amount of poor and overdone work but also to a standard of work which is unrestrained by the severity which stone to a certain degree imposes on design ; a class of work with a prettiness that is frivolous, and lacking in fiber. This is a danger that is imminent, for already the use of terra-cotta is spreading to domestic construction, and in one or two instances noted, is remarkable for an efflorescence of ornament which would do much to discredit any material.

The question of color in terra-cotta is far too large for treatment here, and is important enough for a separate series of papers. It is a matter, however, that does not affect this slight consideration as to how far the constructive uses of terra-cotta are parallel to those of stone. The result of our examination would seem to point to the existence of as strong a case for the recognition of terra-cotta as a material governed by its own peculiar laws, as that on which the individuality of brick architecture is based.

In our consideration of terra-cotta the supposition has been followed that the terra-cotta block has been used constructively as is the individual brick, recent domestic work in terra-cotta warranting one in doing so. The pleasing practice of hanging the blocks with wire to a steel beam is evidently removed far beyond the jurisdiction of the ordinary constructive laws of the pendant material, and for this and other obvious reasons does not enter into the scope of this consideration. What seems to us the redundancy and extravagance of much of the Italian renaissance terra-cotta is also passed over, from the fact that this being the expression of southern natures, any one rashly entering on such a discussion involves not only himself with the great subject of latitude in art, but the greater one of latitudes also.

Differences of opinion exist on most questions, but it would seem as if all might unite on the statement that most modern designers in terra-cotta, consciously or unconsciously, think of their designs in stone, and that such a method not only is opposed to art canons but is unwarranted by the individual character of the material itself.

PRESENT STATUS OF THE NICKEL INDUSTRY.

By W. L. Austin, Ph. D.

ALTHOUGH within the past five or six years the consumption of nickel has very largely increased, still the actual amount of this metal used in the arts and manufactures is insignificant when compared with the quantities of other metals consumed. Statistics published in 1889 show that the total weight of nickel produced in the world at that time did not exceed from one-half to one-third that of the silver and only equalled from 1-150 to 1-250 that of the copper. This is the more strange when the valuable physical and chemical properties of nickel are considered, for although once classified among the precious metals, it is not at all a rare metal. With a specific gravity (8.80) very little in excess of that of iron (7.86), it possesses several advantages over the latter metal, among which may be mentioned greater strength when subjected to a breaking strain, and practically non-corrodibility under ordinary conditions, retaining its brightness and polish even when exposed to the action of vapors and gases which readily attack most of the common metals, silver included. Another valuable quality possessed by nickel is that it can be welded to iron and the two metals then rolled out into thin sheets, which for many purposes are as good as the more costly solid metal. These and other well-known characteristics of nickel may be observed in articles of everyday use, and have led to its employment for plating purposes, culinary utensils, minor coins, chemical apparatus, door-plates, oil-cans, harness-ware, etc.

But the use of solid metallic nickel is still very restricted, owing largely to its cost (50 cents per pound), which in turn is due to the complicated and extravagant methods employed in reducing it from its ores. That there is ample room for improvement in the metallurgical treatment of nickel ores is borne out by the fact that in Norway the cost of mining the ore is only one-seventh part of the selling price of the finished metal. It is not a difficult metal to treat, nor is it as hard to work up as might be inferred from statements current with regard to its infusibility. Cube nickel melts well in graphite crucibles in a good coke fire* and at the Chicago World's Fair among a variety of interesting nickel products the Canadian Copper Company exhibited a block of practically pure nickel weighing 4500 pounds.

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* Wedding in Jahresbericht, Chem. Tech. 1893, p. 281.

The principal trouble experienced in the metallurgical treatment of nickel is in its separation from other elements with which it is found associated in nature, or which are taken up by it while undergoing the various processes to which it is subjected. Even in the case of very pure ores, such as those of New Caledonia, the sulphur, and to some extent the carbon of the fuel, combine with the nickel during treatment, thereby producing an impure metal and complicating subsequent operations.

Whatever new uses the future may have in store for nickel, at the present time it finds its most extended application in the form of alloys with other metals such as copper, zinc, iron, etc. Some of these alloys have for a century or more been known in the trades under a number of fantastic names such as German silver, maillechort, argentan, pack fong, tutenag, etc. ; but the most important of all, the one from which the human race is apparently to derive the greatest benefit, is the alloy with iron, known as nickel-steel, and which has been brought into more or less prominence of late years in connection with experiments on armor and ordnance material instituted by the United States Navy Department.

This alloy furnishes us with another confirmation of the old adage that "there is nothing new under the sun," for in nickel-steel we find the great powers of the earth at the end of the nineteenth century reverting in their armaments to the use of a material similar to that to which primitive man had recourse. Meteoric iron is perfectly malleable and may be easily forged into cutting instruments, and it is well known that such articles have been made by savage and semi-savage nations from this material. Therefore in all probability the first iron employed by man was of celestial origin—all meteorites contain nickel—and where available he utilized it in fashioning his instruments of offense and defense. Now, after the lapse of many centuries, nickel is again assuming an important rôle in the preparation of war material, for the bullets of modern military rifles are cased in a nickel alloy, and iron alloyed with nickel is largely used in the manufacture of modern guns and protective armor.

Nickel, although not as predominant as many other metals, is very widely distributed over the earth's surface, more so than is generally supposed to be the case. Outside of the few well-known important deposits mentioned below, there are others existing which are considsidered of lesser importance at present, to which many more would undoubtedly be added, were any considerable demand for the metal to arise ; for nickel in its mineralized form is not easily recognized even by those whose calling familiarizes them with ores, and therefore often escapes notice.

The two most important deposits of nickel ore at present known to exist are found on the island of New Caledonia and in the Province of Ontario, Canada. Large deposits of less importance occur in Norway, Sweden, northern Italy, Germany, Austria and Russia, while ore bodies more or less extensive exist in the Provinces of Quebec, British Columbia, and New Brunswick in Canada, also in Spain, Greece, Tasmania, New South Wales, India, Great Britain, South America and in Baja California, Mexico. In the United States important deposits are found in Oregon and Nevada, while nickel is known to exist in the states of Arkansas, California, Colorado, Connecticut, Idaho, Iowa, Kansas, Michigan, Missouri, New York, North Carolina, New Jersey, Pennsylvania, South Dakota, in the Territories of Arizona and New Mexico, and in the "Lake Superior region."

The mines of New Caledonia and Canada supply nearly all of the nickel used in commerce to-day, although those of Norway, Sweden, Germany, Austria and Russia furnish a small quota ; but in this country very little, if any, nickel ore is mined now.

The New Caledonian ores are of a higher average grade (6 to 8 per cent. nickel) than those of Canada and are more free from deleterious materials. The extent of these deposits is very great and it is stated that over 120 square miles of nickeliferous territory is being exploited by mining companies in New Caledonia at the present time. The veins are sometimes 25 feet in width, and at places the whole rock is traversed by small seams of ore forming mineralized zones which are mined for a width of over 200 feet. Only the large veins in the solid rock are operated by underground workings, the ore being mostly quarried out of the mountain side. These workings occur at points lying from 900 to 1800 feet above sea level. The New Caledonian ores are what is known as hydrated silicates of magnesia and nickel and are intimately associated with serpentine. They are remarkably pure, containing no sulphur nor arsenic, and are free from copper. These mines can produce very large quantities of ore if there should be a demand for it ; in fact there is a tendency toward over-production even now, the value of the stock on hand in 1893 being largely in excess of that of the preceding year.

The Canadian ore-bodies consist for the main part of iron sulphides with which 2 to 3 per cent. of nickel is associated—a totally different character of ore from that of New Caledonia. The nickel is accompanied by copper, which is in one respect a drawback, because the metallurgical separation of these two metals has been always attended with considerable difficulty and expense. The Canadian mines could, single-handed, easily supply the world's present nickel requirements were they called upon to do so, but owing to the light demand for the metal the large companies at Sudbury for the past couple of years have worked only intermittently, shutting down their smelting works during the winter, and even then accumulating a larger stock of matte on hand than could be profitably disposed of. Various reasons have been advanced to account for the desultory work done at Sudbury, it being even averred that the large companies were purposely depressing the market with a view to "freezing out" small competitors, or for the purpose of discouraging certain stockholders: but the fact of the matter is that the capacity of the Canadian mines for producing nickel far exceeds the present demand for that metal at existing prices. If by means of improved methods of reduction crude nickel, free from deleterious admixtures, were placed upon the market at the present price of copper, and this is quite within the bounds of possibility, the probabilities are that the metal would find a much more extended use, and lead to greater activity at Sudbury, as well as to the exploitation of other nickel deposits now lying idle. Sulphide ores, such as those of northern Italy, Norway and Canada should be very easily and cheaply worked on account of their basic character. Such ores possess many points of advantage over the refractory magnesian silicates of New Caledonia, which in fact are usually converted into the form of sulphides as an intermediate step in their treatment. The same statement applies equally in the case of the rich arsenide and antimonide ores of Austria and Nevada.

The total cost of producing nickel from the New Caledonian ores in 1885 was, according to du Peloux, between six and seven francs per kilogram metallic nickel. The methods employed for extracting the metal from this ore have been materially improved since then; but as the ore is all shipped to Europe for treatment, the cost of transport from interior points to the coast, freight to the European establishments, and subsequent expense in extracting the nickel, have rendered the business a not very profitable one. The cost of producing nickel from these ores has not been very much below the price obtained for it in the market.

In Canada the ore contains copper as well as nickel. Levat estimates that a unit of nickel can be produced from the Canadian ores for about the same price as from those of New Caledonia; but in the former case, when a copper-nickel alloy is admissible, the unit of nickel contained in that alloy costs considerably less. Ever since nickel became the object of systematic reduction in the early part of the present century, its physical qualities have been enveloped in more or less mystery owing to small quantities of impurities being associated with it which very much affect its fusibility, tensile strength, etc. Various investigators have ascribed to it different attributes, not having clearly comprehended the influence exerted by the presence of small quantities of one element upon large masses of another. The reduction of the metal from its ores has been usually accomplished by secret processes and its passage from the hands of producers into those of consumers is not readily followed. The very quantity of nickel produced in the world is a subject of controversy, different authorities placing the amount at widely varying figures. For instance, one authority places the yearly production of the world for the years 1890, 1891, and 1892 at respectively, 2000, 2500, 4500 and 4000 metric tons, while no less an authority than "Mineral Industry" states that the production for the years named was respectively 2650, 5164, and 6077 tons.

The large increase in the production of nickel during the past few years is mainly due to the introduction of the metal into material designed for war purposes, the toughness of nickel-steel having been found of considerable value in the manufacture of objects which are to be subjected to sudden and excessive stresses. It has been found that steel alloyed with a small percentage of nickel (3 to 4 per cent.) possesses great tensile strength with a corresponding elastic limit. The percentage of nickel used in the alloy has a marked effect upon its physical characteristics, the advantage of steels containing a low percentage of nickel not being found in richer mixtures. For instance, a gun manufactured of steel carrying 27 per cent. nickel did not give satisfactory results, treatment after forging reducing its physical qualities below simple steel.

Up to the present time nickel-steel has met with an extended use only on the part of national governments, such being the inertia of custom that it has not been introduced openly into the arts and manufactures. This is partially due to expense attending its manufacture, partly to a conservative spirit which hesitates to employ a new material, engineers not caring to call for it in their specifications and manufacturers hesitating to advocate its introduction. It is very important for the nickel industry that this nickeliferous iron alloy should meet with a general introduction because in that case nickel would find a ready and ever-increasing market. That such a desideratum can be reasonably looked forward to is foreshadowed in the opinion recently expressed by one of our best authorities on steel subjects who stated in a letter to the writer that the qualities of nickel-steel are simply marvelous and if properly pushed it should have a great future. On this account the future of the metal seems closely bound up with that of nickel-steel and the limited extent to which this material has already been employed has given the nickel industry a considerable stimulus, the remarkable results obtained from physical tests of this material affording much hope for its ultimate extended use. Although the results obtained in the cases of certain Harveyized plates recently submitted to the Government for testing purposes caused some doubts to be cast upon their effectiveness, still the many tests of a similar nature which preceded the ones referred to and which turned out successfully, and others which have subsequently been made, render it more than likely that in these particular cases failure cannot be charged up against the alloy. As is the case with every new industry, perfection has not been attained at once, and some failures must naturally be expected ; but it has not been by any means demonstrated that the disasters which overtook the particular plates mentioned are to be ascribed to any inherent weakness in the nickel-steel itself. An accumulation of evidence obtained at Krupp's works in Germany, at the Ochata trials in Russia and at the many tests made at Indian Head and other places in this country and in France has been obtained, which goes to show conclusively that nickel-steel plates, when placed side by side with those of ordinary steel, and subjected to severe tests, are capable of withstanding greater punishment than the latter. As stated, this fact has been established upon American and foreign proving grounds again and again so as not to admit of any reasonable doubt remaining upon the subject. However our naval authorities were not satisfied with the resisting powers of nickel-steel plates but wished to carry the matter still further, and to provide for the new war vessels building a material of great surface hardness in addition to toughness so that the projectiles should be broken up on their surfaces, they still possessing the quality of not cracking. If in thus attempting to produce an ideal plate, one possessing the toughness of nickel-steel at the same time with an extremely hard outward surface, it has been found that further experience in the methods of manipulation is necessary before attaining perfection, it is hardly logical to ascribe a casual failure to any inherent weakness in the nickel-steel itself. When it is considered that the presence of 0.1 per cent. of carbon, more or less, in a plate constitutes the difference between a material which will resist cracking, or one which will fly to pieces under the impact of projectiles, the extreme caution necessary in proportioning the ingredients is apparent. Furthermore the effects upon steel of the various processes of annealing, tempering, etc., are factors which demand serious consideration, especially in the case of heavy armor plate subjected to severe test shortly after manufacture.

Apart from the mechanical and chemical processes to which the plates are subjected, the incorporation of the nickel into the alloy during the process of manufacturing the steel may also have a considerable bearing upon the results produced. In France, which was the birth-place of nickel-steel, the method of incorporating the nickel into the bath was for a time through the medium of ferro-nickel. This material, which corresponds in a measure to the compound of iron and manganese known as ferro-manganese used extensively in the manufacture of steel, was prepared from ores of the two metals and subsequently introduced into the steel bath. This process of manufacturing nickel-steel is explained at length in the patent specifications of both Schneider and Marbeau, and has much to recommend it. It is only rational to assume that where two metals, iron and nickel, are already alloyed in the ferro-nickel, the latter will become very evenly diffused through the steel bath when the ferro-nickel is introduced into it. At present the French manufacturers appear to have substituted metallic nickel in the place of ferro-nickel in manufacturing their nickel-steel; but in either case the nickel is introduced into the steel bath in the metallic form. In this country a different method has been employed by our nickel-steel makers—one which, when the object to be obtained is considered, does not commend itself either upon chemical or mechanical grounds. The nickel is introduced into the steel in the form of what is known as "commercial oxide," and the incorporation of a small amount (between 3 and 4 per cent.) of nickel, in the form of oxide, into a bath of steel so as to form a homogeneous alloy under the conditions named is hardly to be expected. It is difficult to understand how the nickel can become evenly distributed throughout the bath, and if by chance the oxide should not be thoroughly reduced the cohesion of the whole mass is naturally weakened. *A priori* it would appear as though the European practice of incorporating the nickel in the metallic form were the one most likely to lead to uniform results, and the practice of using nickel in the form of oxide may account in some cases for the uneven results obtained over here. The production of alloys is not always an easy operation; but there are other metals forming component parts of alloys in common use, which possess essential characteristics so widely differing from each other that they are much more difficult to alloy than is the case with nickel and iron; yet practice and experience have overcome the difficulties at first encountered. Similarly happy results may be confidently expected in the case of nickel-steel when the manufacturers have gained the requisite experience, and probably occasion to refer to blow-holes or uneven distribution of the nickel will not then arise so often.

One point clearly established by experience with nickel-steel up to the present time is, that as far as applied to large castings the alloy has unquestionably come to stay, but to what extent it can be utilized for smaller articles remains yet to be proved. There appears to be no good reason why it should not eventually find general introduction wherever a tough steel of great tensile strength is required.

The non-corrodibility of nickel would seem to fit it especially for culinary utensils, and these have been placed upon the market for some time, manufactured both from solid nickel as well as combined iron and nickel plate, manufactured in the manner already mentioned. The method of welding nickel to iron and then rolling them both to plate, gives us a material possessing most of the desirable qualities of nickel without its excessive cost. Iron " plated " in this manner does not readily part with its nickel coating, as is so generally the case when it is plated by galvanic action.

Solid nickel coins have recently been issued by some of the European governments, and alloys of nickel and copper, the so-called " nickels " in common use, have long been in circulation in this country and elsewhere ; but the uses to which *metallic* nickel is put to-day are comparatively few, and will probably remain so until improvements are introduced for reducing the metal out of its ores.

WHY SOME MEN FAIL AS STEAM-ENGINEERS.

By W. H. Wakeman.

AT the beginning of this paper the writer wishes to define the word "success" as herein used. To attain success as a steam-engineer it is not necessary that a man should secure a position where the highest salary is paid, nor yet where the largest engines are in operation. Both of these are desirable, and we have no desire to belittle them, or to make it appear as if it were an easy matter to attain to them, but we repeat that they are not necessary to success in the work of a steam-engineer. The man who reaches a point where he can truly claim success in this business, has done something more than recline "on flowery beds of ease," for both brain and hand have been as busy as the far-famed bee who "gathers honey all the day from every opening flower." Yes, even more busy, for while the bee retires to rest with the coming of twilight, he who would succeed as a steam-engineer has continued his labors and studies far into the night, and oftentimes rises long before the bee.

If the highest salary and the largest machine are not necessary to success, then what are the attainments that will put a man where he will be satisfied with his condition, or at least as nearly satisfied as it is possible for a mortal to be? In the first place, he must have a salary large enough to enable him to support his family decently and educate his children, and, in the second place, he must be so situated as to be free from unnecessary care and anxiety. It is of this second necessity that we wish to speak more particularly, for it is this which causes a large part of the dissatisfaction among stationary steam-engineers. This statement is made without fear of successful contradiction, for the writer knows whereof he speaks. It is worth while to repeat that it is the unnecessary care and anxiety frequently put upon the engineer that causes him to be dissatisfied, and is responsible for many of the changes in situations so constantly reported among the craft. There are many cares and perplexities that are a necessary part of the engineer's work, and to these the competent engineer does not object, for he expects them to be a part of his regular duties, but when more than this is put upon him, the instinct of self-preservation causes him to look elsewhere for work. If any reader has always believed that men seek new situations solely because they are to receive larger salaries, let me ask why it is that men are often known to go to places where they are to receive less wages than formerly? I have known a steam-engineer to deliberately leave a situation and accept another for a salary 30 per cent. less than he was receiving. There must be some reason for such apparently inconsistent action. It is not because the care of the engines, boilers, and other machinery proves to be too much of a burden, but because the proprietor or superintendent is more of a burden to the engineer than all of his machinery would be were it multiplied four-fold. There are few proprietors of steam-plants who are practical steam-engineers, yet many of them presume to dictate to the men who feel that they understand their business, and sometimes insist on their engineers doing the most absurd things that could possibly be imagined. Now we are perfectly willing to admit that when a man builds a factory, puts engines and boilers into it, and pays all the bills, he has a perfect right to say how many hours the machinery shall run, to insist that it shall be well cared for in every way and be kept clean and in good repair, that if coal is wasted, or oil and waste disposed of unprofitably, it is his right to call attention to these leaks and have them calked up. But for him to attempt to act as his own engineer is not good sound business policy, and the reason for this conclusion is a very simple one,—namely, because he can hire a competent engineer to do this work much more cheaply than he can afford to do it himself. Some of our best business men are convinced of this and act accordingly, but others are not, and to these a few remarks may be addressed.

If you have a sober, honest, and faithful man in your engine-room, but one to whom you have never given full charge of your plant, commence to place responsibility upon him, cautiously at first, carefully noting how he conducts himself, and, if he proves worthy of your confidence, honor him with greater trust until he runs the plant entirely, and feels that he must demonstrate that your confidence is not misplaced. If he is the right kind of man he will meet you more than half-way, and soon you will wonder how you could have ever been so foolish as to have spent so much time in watching a man whom you called your engineer, but in reality was only your fireman. When this plan is in successful operation, you will be perfectly willing to pay him more wages, because he is actually earning more money for you. Thus you will be better off, and he will have what rightfully belongs to him and will prove a successful engineer. There are many men employed in the engine-rooms of medium-sized plants who are well worthy of such treatment, but, owing to the short-sightedness of their employers, they never receive it, and hence never become successful. A case well known to the writer will serve as an illustration.

The proprietor of a certain factory believes that one small drop of oil per minute is sufficient for the lubrication of the valves and piston of his engine. The man who is nominally the engineer thinks otherwise. If the proprietor comes into the engine-room during the absence of the engineer and finds more than one drop ascending per minute, he reduces the amount to what he calls sufficient. After a time the engineer returns, finds the oil feeding slower than he knows it ought to, and so increases the feed. This performance is repeated until the engineer becomes exasperated, watches his opportunity, and, when the proprietor alters the feed again, in common parlance, proceeds to "read the riot act to him."

Now if the cylinder of that engine is found to be badly cut and grooved when the machinery is overhauled, who will have to bear the blame? Will the proprietor assume it? If any one supposes that he will, he will find himself sadly mistaken. It is all very well to tell others how well he runs things, and how wasteful the engineer would be were it not for him, but when any damage is done by such mismanagement they are perfectly willing to blame the engineer for it, and, if he protests, will claim that the engineer should have corrected any wrong practice of that kind, as that is what he is hired for. If he has failed to do his duty, he alone is to blame. Furthermore, mechanics and the public in general, when they hear of any such trouble, will agree with the proprietor, and engineers who do not understand all of the circumstances will hold the same opinion. Under such conditions it is almost impossible for any man to become a successful engineer. But the cause of failure does not always lie with the proprietor, far from it. If an individual starts out with the firm determination to become a successful engineer, and goes about it in the right way, it will not be an easy matter for any one to prevent him from becoming one.

The greatest source of weakness is found in the engineer himself, and to some of the primary causes of this lack of strength I wish to call attention, hoping that some one will be benefitted thereby. If it were possible to hire only experienced engineers in all cases it would be well to do so, but while it is true that engineers are "born and not made," still it requires experience and practice to make perfect; therefore some men will always be found in charge of plants who have had but little experience, and who have many things to learn.

Let us take the case of a young man who finds himself in charge of a steam-plant of moderate size. He understands that his principal duties are to shovel coal into the furnace, keep up steam, clean fires, start and stop the engine at the proper time, and keep it clean. He resolves to attend to these duties, and do nothing more. These are what he is paid for, and why should he do any work for nothing? After he has been in charge of the place for some time he meets several comrades in the same line of business, and they begin to talk about their plants. Some questions about back-pressure valves arise, and he is asked what kind of valve he has and how much weight he carries on the lever. He replies that he does not know, for he never saw it. This valve is located two floors above his room, and is not in his jurisdiction. He never expects to meddle with things that do not belong to him, and will be careful how he gives the boss the idea that he is trying to run the whole shop. Now his listeners put their valuation on his services without delay, and usually it is a proper one. They may not proclaim it in loud tones, for it is far more pleasant to compliment a man than to condemn him, but they understand the situation none the less. Soon cold weather comes on, and the operatives in the factory want steam to warm the rooms. He turns it on, but pays no further attention to the matter. The time comes when they want to shut off the steam from one room for some purpose. They ask the engineer to attend to it for them, but he replies that it is the least of his troubles where the steam goes to after he has got done with it. Again he is requested to tell them what to do or to shut the steam off for them, and, as he has no good excuse for refusing, he goes up into the designated room and simply exposes his ignorance, for he cannot tell where the steam enters or leaves the room. Thus the men in the factory where he is employed lose respect for him, and rate him as an ignoramus.

Again, the time comes when the valve-gear of his engine needs repairs. The proprietor sends for machinists, who come and look the machine over, see what is to be done, make calculations accordingly, and agree to come the following evening and have the job done in time to start up the next morning. During all this time our friend the engineer stands and idly looks on, apparently caring nothing about how the work is done, for he was hired to run the machine, and not to keep it in repair. At the usual time for shutting down on the next day he stops his engine, washes up, and goes home. Just before he leaves, one of them inquires if he is not going to stay and see that the repairs are made according to what he thinks is right. His answer is decidedly in the negative ; they can make them as they choose. He is going to an entertainment that evening, and then proposes to take his usual rest. He arrives on time the next morning, finds the repairs finished, and starts the machinery, but how much does that man know about repairing an engine, more than he did the previous week? Nothing at all. These machinists give him a rating according to what they have seen of him and his way of doing business. Does their opinion prove to be of any advantage to him? Quite the contrary.

One more illustration along this line will suffice. The main belt on his engine needs relacing. He does not get a man out of the factory to help him lace it, but simply reports it to the superintendent, who tells him to stop the engine at noon so that the place where the belt must be relaced will be accessible. This he does, and two men come in and in a great hurry proceed to put on the clamps, cut out the old lacing and put in new, for the power must be running at 1 o'clock without fail. The result is that the belt is not really laced, but is only tied together. During the operation the engineer was eating his dinner, paying no attention whatever to his belt. Did these men respect him and think that he was a great man because he would not assist them? Not at all, for they simply said that he did not know how to lace a belt, and added that they were of the opinion that he never would learn. By what process is this man to become a successful engineer?

In speaking of the above-mentioned mistakes, those have been singled out that represent certain classes, each one of which stands for numerous others of like nature, so that if any reader has not made the particular mistakes to which attention is called, but has made others of the same stamp, he will know what is meant.

There is one blunder, made by some engineers, that deserves to be set apart for special mention. It is the practice of going into a saloon to get a glass of beer to create an appetite for dinner, and, as soon as the day's work is done, to hasten to the same place, where the smell of stale beer and poor cigars makes the air unfit for breathing, and there spending the evening in gaming and drinking, returning home with foul breath and dull brain, to partially sleep off these effects before it is time to begin work again, only to repeat the same practice the next day. I do not wish to convey the idea that engineers as a class are guilty of these bad habits, for they are not, but that some of them are cannot be denied, and we condemn, not the men, but their practice, with a zeal that is deep-seated and uncompromising. If there is any class of men that should be possessed of steady hands and clear brains it is the steam-engineers,—locomotive, marine, and stationary. Why do men allow their appetite for a drink that does them no good, but only harm, to stand in the way of advancement in their profession, and the improvement of their own condition, and happiness of their families?

The writer has just finished reading a chapter written by a friend who has had forty-five years experience as an engineer, and who somewhat facetiously remarks that during that time he has known but two engineers to die, and one of them was drowned. We accept the joke, but would add that while our experience has been of a shorter duration than this, we have known several to die, and more have been promoted to better situations, while some have been discharged for incompetency and bad habits, the consequence being that others must fill their places. Now suppose that some of the friends of the man that we have called attention to hear of one of these places, and make inquiries as to what kind of a man is wanted. They find a good place to work in, and a fair salary offered. In return for this the proprietors want a man to run their plant, attend to all repairs on it, care for the main belt, and see that the heating system is in good repair and working properly. He is not expected to do all of these things himself, but to understand what is wanted, and have them properly attended to, and at the right time. Here is room for a fair question. Can any of these friends go to the proprietor of this plant and recommend this engineer as a man who can fill the bill and give perfect satisfaction? They have no grounds for stating that this is true, for he has never repaired an engine, laced a belt, or studied out the principles on which steam-heating systems operate, and from present indications he will not do any of these things until he is compelled to. The natural consequence is that he is not recommended, and when he finds out that another has secured the situation, he curses his hard luck, and explains to his friends that if he had more money, or a greater "pull," he could get a better place with more wages. But the whole cause of his failure may be summed up in one word—"incompetency."

These are no fancy sketches, but are taken from conditions in real life with which we are in contact every day. Men are not always appreciated, and hence sometimes become discouraged, while in other cases they are not respected, because they do not cultivate qualities worthy of respect. These are the facts in these cases and a study of them will repay the time spent in it, but a dogged denial of them will benefit no one.

THE WHALING INDUSTRY.

By Herbert L. Aldrich.

SO little has been heard of the whaling industry during the rush and excitement of the last quarter of a century that many people suppose it to be but a reminiscence. This is by no means the case. The industry was nearly annihilated during the war, but since then there has been a slow but steady increase from a few vessels to a fleet of forty or more engaged in Arctic whaling, and this branch of the service is about all that remains of a business that gave employment to a fleet of over 500 vessels half a century ago.

But now the decline seems to have begun, and with the changes brought about during the past two years, the indications are that sailing vessels cannot much longer make whaling remunerative, and that they must give place to a small fleet of steamers that shall practically live in the Arctic, for periods of two years or more.

Whaling is distinctively an American industry now as it always has been. Indeed there are hardly more than a dozen whalers that do not fly the American flag, and these are Scandinavian vessels, both steam and sail, and English and Scotch steamers which make combined whaling and sealing voyages along the northeastern coast of North America. One or two American whalers also cruise along this coast nearly every year, but they pursue entirely different tactics from the steamers. The steamers follow the whales up into the Arctic as far as it is safe to go, while the American vessels, which are always small brigs or schooners, go only as far north as Hudson's or Baffin's bay where they cruise for a few weeks in midsummer. When cold weather approaches they go into Hudson's bay and freeze up with the ice.

It is rare good fortune if one of these vessels catches a whale outside of the bay, for the success of the voyage is staked on being in the bay in the spring and catching the whales before the ice at the entrance to the bay breaks up.

From a commercial point of view there are three kinds of whales, sperm whales, right whales, and bowhead, or Arctic whales.

Sperm whales have no baleen, or whalebone, but the oil they yield is worth three or four times as much as oil from either of the other whales. They inhabit tropical and semi-tropical seas. When in a certain diseased condition these whales give out an excrement called ambergris that is quite invaluable in perfumery making, and which occasionally sells for fabulous prices, not infrequently as high as ten dollars or more an ounce for choice specimens. But the man who goes sperm whaling with a view to getting ambergris goes on a fool's errand, as many a whaleman has been on voyage after voyage of three to five years duration each and yet not even seen it.

The female sperm whale, or cow as she is called, is small and seldom produces over twenty barrels of oil ; but the male, or bull, sometimes exceeds one hundred barrels in size, as the whaleman's system of measurement expresses it. The bull sperm is the most vicious of fighters among whales, and it is with a great sigh of relief that the carcass of one is hauled alongside the ship, and the boats again hung on the davits, with no damage done to them, and none of their crews killed.

But the danger of the chase is by no means as great now as it was in years gone by, because of the introduction of bomb lances. If one bomb is shot into the "bilge" of the whale, and exploded near the vitals, it will so cripple him that his final "flurry" is short, and death is not infrequently instantaneous.

The right whale occupies the intermediate seas between the tropics and the Arctic, his chief haunts being the waters in and about Bering sea. He averages larger in size than other whales, and unlike sperm whales, the females are usually larger than the males. One hundred and thirty barrels is not a very unusual size for a right whale. But in spite of his size, he is not as valuable as the bowhead whale, since his whalebone is inferior in quality and less in quantity. Otherwise there is no material difference between these whales.

Sperm whaling voyages frequently extend over a period of two or three years, or more, but other whaling voyages seldom exceed eleven months. Nearly all the right and bowhead whalers sail from San Francisco, returning to port about December first to dispose of the season's catch. They are immediately refitted, new crews are shipped, and in a few weeks are at sea again.

When a vessel starts out on its voyage, it goes to a certain "ground." The right whaling grounds of value are the Okotsk, the Kodiak (which is the great bight southwest of Alaska), the Japan sea, and Bering sea. The only bowhead ground is the Arctic ocean and adjacent waters, especially Bering sea and the ocean beyond.

Twenty-five years ago there was a fear that the whales would be exterminated, and this fear came near being realized so far as the sperm whale was concerned, for at that time sperm oil commanded an enormous price, while whalebone and whale oil (the generic term for the oil of other species of whales than the sperm) were in but limited demand. But substitutes have been found for sperm oil so that the demand for it is now small and the price correspondingly reduced. Nothing however has yet been discovered that possesses the peculiar qualities of whalebone, hence its value has risen from a few cents a

STEAM WHALER IN THE ICE PACK "BOILING OIL."

FROZEN IN THE ICE OF BERING SEA.

A TYPICAL WHALING VESSEL.

WHALING ON THE COAST OF SIBERIA.

pound to seven dollars and a quarter, the highest price yet reached. With this increase in the value of bone, the chase of the whalebone producing whales has been pursued with increased vigor until their numbers have been much reduced, and those remaining have become very shy. The right whales have no safe retreat to flee to, although there are certain bays on the coast of Siberia that Russia has closed to whaling vessels. The bowheads have the Arctic ice as a refuge, but only for a few weeks in midsummer, as the same gales and cold which drive the whaleships out of the Arctic also drive them out.

The bowheads spend the winter along the edge of the line of ice in Bering sea, but early in the spring they push northward through the ice pack as it breaks up and opens the way for them into the Arctic. But the same conditions that make it possible for the whales to go into the Arctic also make it possible for the whaling vessels to go, and in this "outside whaling," as the Bering sea whaling is called, the fleet usually makes a catch of from twenty-five to fifty whales.

After the whales enter the Arctic they scatter along the edge of the solid north pack. Usually most of them go far into the northeast, up to, and beyond Point Barrow if the sea is free enough from ice. But occasionally the whalemen search these waters without finding evidences of a whale. This makes them apprehensive lest the season in the Arctic shall be a failure, so they head their vessels westward, beat along the edge of the pack, and usually find the great body of the whales somewhere between Point Barrow and Herald island. In the year 1887 when I was in the Arctic as the guest of the fleet, whaling became very "dry" about Point Barrow, and the sailing vessels, which stood small chance of making a catch when the steamers pursued closely the few whales that were seen, went westward.

The long absence of these vessels, and the final disappearance of all whales at the eastward, led the masters of the steamers to conclude that their fellow masters of the "wind-jammers," as the sailing vessels are called, had made a wise move, and they followed after. The master of the steamer *Orca*, which I was on board of at the time, ordered steam up, and we followed along the edge of the pack far into the northwest of Herald island, only to be rewarded by encountering a terrific gale which lasted for several days. Returning again toward the eastward we found the whales, and in a few days were "high-hook," having caught twenty-eight whales, the best record that has ever been made by one vessel for so short a season in the Arctic.

Before the gale scattered the whales the sailing vessels had also made good catches of six or eight whales each, so that altogether the "season" was one of the most profitable in the history of Arctic whaling.

The low price of oil, which averages perhaps five hundred dollars to the whale, and the enormous increase in the value of whalebone, which reaches about four thousand five hundred dollars per whale, has led some captains to save only the whalebone of each whale killed, then cut the carcass adrift. The indications are that this system of whaling will soon become quite general. If it does, whaling will be shorn of its most interesting feature and be reduced to mere whale-butchering voyages.

I cannot better describe the operation of capturing a whale and "cutting-in" than by depicting the most exciting whaling scene of the dozens that I witnessed.

Eight vessels, two steamers, and six sailing vessels were at anchor in the bight under Cape East, Siberia. This is the easternmost extremity of Siberia and is at the narrowest part of Bering strait. The vessels lay at anchor along some shore ice. Two "lookouts" were aloft in each "crow's nest" watching for the appearance of any whale that had the temerity to attempt to pass by into the Arctic.

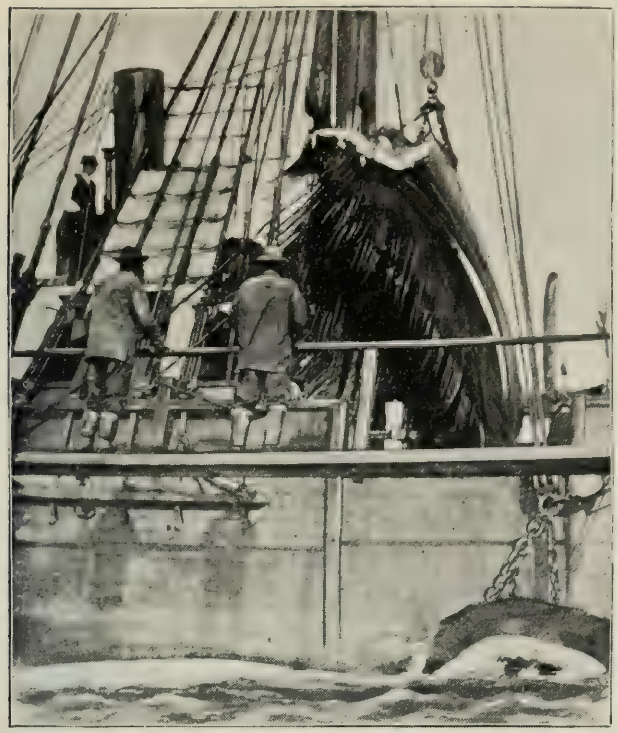
Immediately after dinner one day the "lookout" on the southernmost vessel raised the cry of "b-l-o-w-w." The echo of his call had scarcely died away before the whaleboats of this vessel dropped from the davits into the water, set sail, and scattered about to watch for the next appearance of the whale. Boats from the other vessels were not far behind, and within five minutes from twenty-five to thirty white sails were darting about over the water, each boat's crew hoping to be nearest the spot where the whale should rise to blow. Neither a paddle nor an oar is ever used in the chase, as the hearing of the whale is so acute that danger would be scented at the first touch of the water with them.

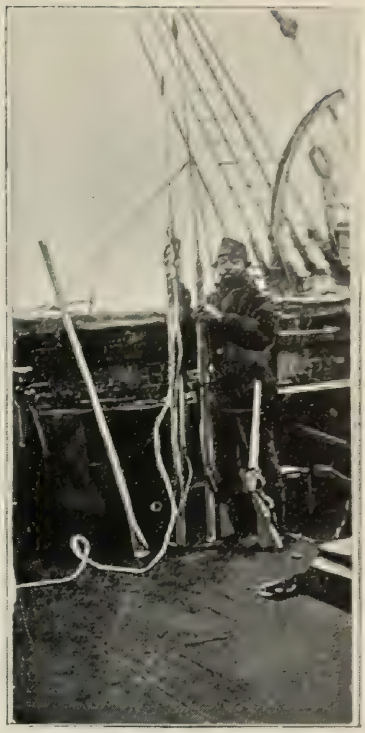
The "lookouts" on the several vessels were signalling to their boats with flags, directing them as to how they should maneuver. But it was all guess work. No one could even approximate the spot where the whale would rise.

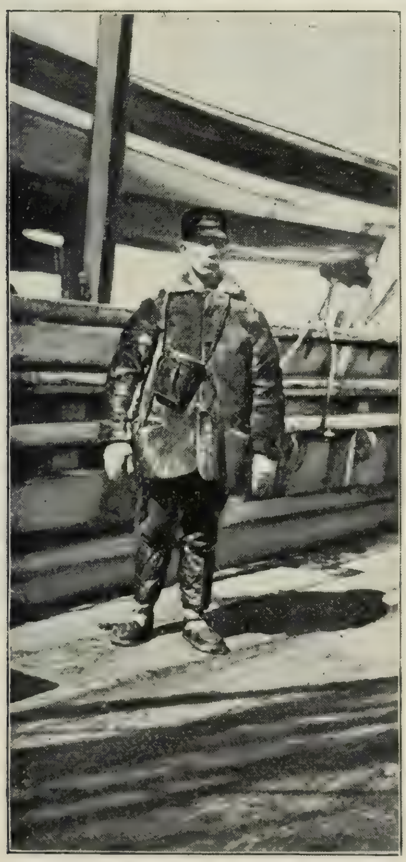
Six captains and I had been dining on the northernmost vessel, the *Narwhal*, and we had just come on deck when the whale was "raised." With but one long-glass to go around, we took turns in watching the scene of action which was some three miles away.

A great shout came from all sides, and a "b-l-o-w-w" sounded from each "crow's nest," as the whale's head appeared above the water within striking distance of one of the *Lucretia's* boats. There was a quick maneuver; the boat-steerer darted his harpoon into the whale, and "fast boat," "fast-boat," resounded from every vessel.

It was a magnificent sight as the whale milled about and started out to sea at a high rate of speed, towing the boat after him. The







"HURRAH FOR FIVE AND FORTY MORE."

TYPICAL DRESS OF A WHALING MASTER.

A WHALEMAN WITH DARTING GUN, HARPOON WITH LINE ATTACHED, SHOULDER GUN, LANCE, AND CUTTING SPADE.

WHALEBOAT IN THE ICE.

boat steerer had struck the whale abaft the vitals and only wounded him, so that it was yet far from certain whether he would be captured.

The whale went out to sea two or three miles, towing the boat at such speed that it did not ride over the waves but cut through them, throwing spray like a torpedo boat. Then he turned about and doubling his wake, sought the protection offered by the shore ice near the ships. Probably half the whales that are wounded in the Arctic regions escape by taking to the ice, either because the boats cannot follow them into the ice, or because the lines become tangled among the rough edges on the under side of the ice, and perhaps cause the "irons" to "draw."

The instant the whale headed shoreward four of the captains and I took the only steam whaleboat in the fleet and joined in the chase, as there was little hope of saving the whale unless more bomb lances could be shot into him, and as yet not one of the other boats had had opportunity to shoot him.

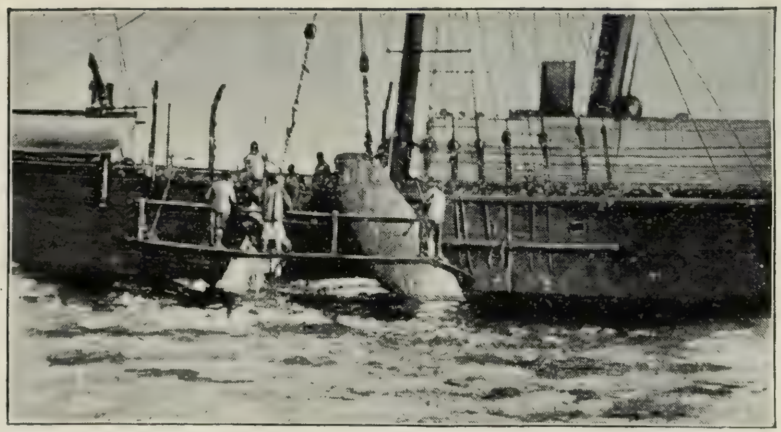
At the north end of the floe was a bight in the ice. The whale passed in under the ice and suddenly appeared in this bight to "blow" for the first time since he was struck. Before he could "sound" our boat had steamed around into the bight and was alongside of him.

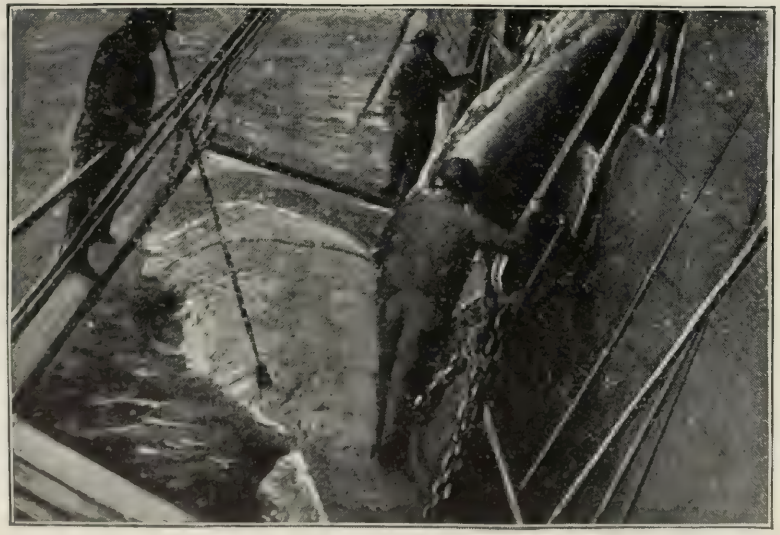
The captain of the *Lucretia* stood in the forward end of the boat with shoulder gun in hand ready at the proper instant to shoot; and the master of the *Eliza* stood amidship, also with gun in hand. It was only for an instant that we saw the whale as we steamed past at a high rate of speed. But the captains were alert. There were two loud reports that almost deafened us, and that made the boat tremble from stem to stern. The whale gave a sweep of his flukes through the air as the bombs exploded, and rolled over, dead. The sweep of his vicious tail was a second too late to hit the boat, and we caught only the swash of the subaqueous convulsion as we rushed by.

When the whale is dead the excitement ends and the hard work begins. The boats of the ship to which he belongs "hook-on" to him, and tow him alongside of the vessel. His head is placed just abaft the gangway, and great "fluke chains" are fastened around his flukes; then the work of cutting-in commences.

The "head," or what would commonly be called the upper jaw, is the most valuable part of the whale because it contains all the whalebone, and there is much anxiety on the part of the crew until it is cut off and landed safely on deck.

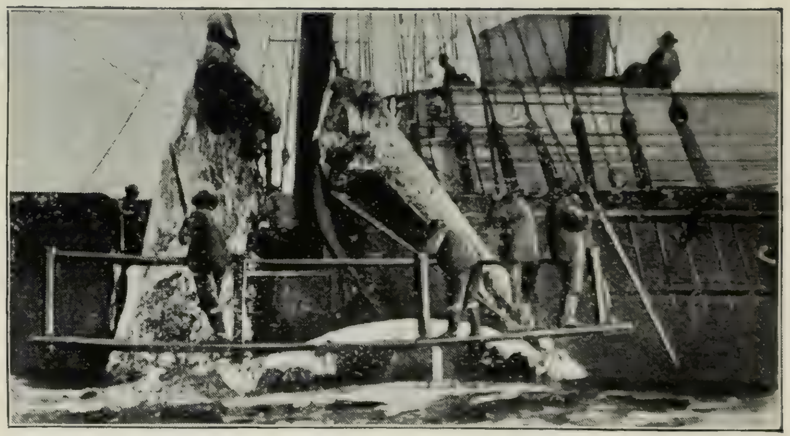
The manner of cutting this off usually depends upon the position in which the whale lies. If in one position it is necessary to cut off one lip, and possibly the throat, before the "head" is reached; if in

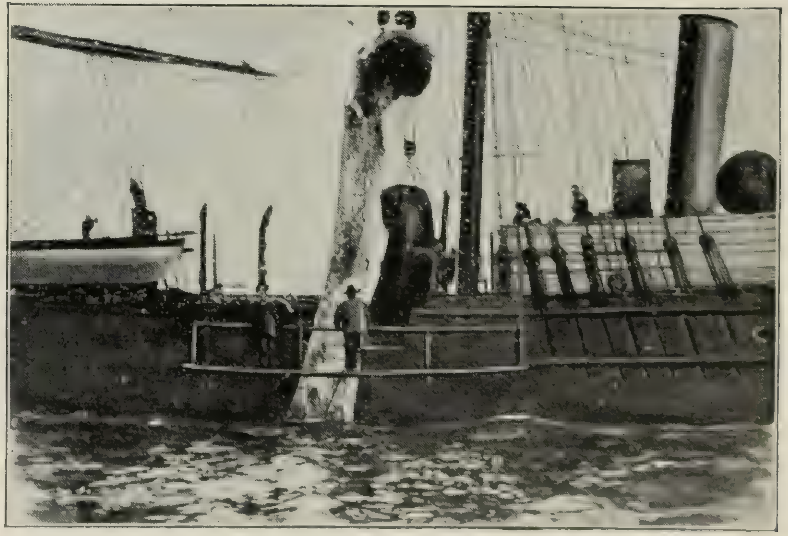




CUTTING OFF THE THROAT OF THE WHALE.

STARTING THE " BLANKET PIECES."





CUTTING OFF A LIP OF THE WHALE.

A " BLANKET PIECE."

another, both lips and the throat have to be cut off. Sometimes the carcass can be rolled so as to bring the "head" uppermost. In either case, the spinal column is cut in two with axes where it unites with the skull, and when with a final jerk the two parts separate, and the "head" is safely landed on deck, there is a suspension of work, and all hands throw up their hats and shout, "Hurrah for five and forty more!" When oil was the prime object of the whaleman's search this time-honored shout of victory was reserved until the flukes came over the rail, but now that whalebone is the object of the voyage, the place of rejoicing has been changed from the tail to the head.

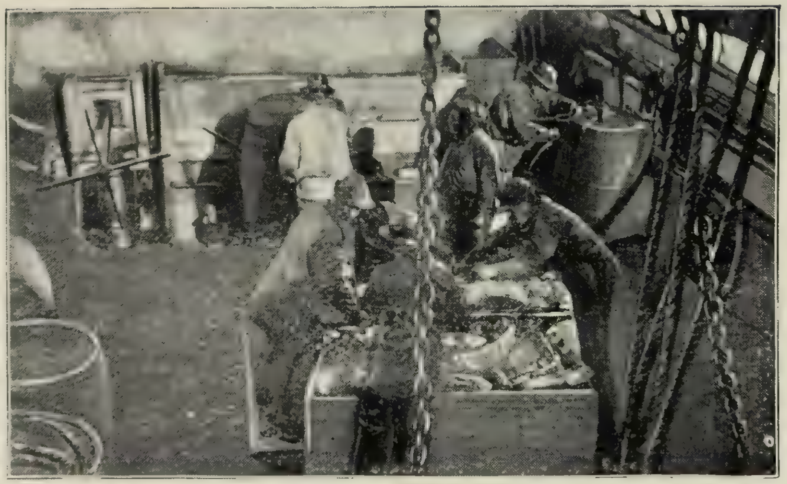
The "head" is put one side until the blubber is all cut off the carcass, then the slabs of whalebone are carefully separated and stowed away to be scraped, washed and cleaned later on.

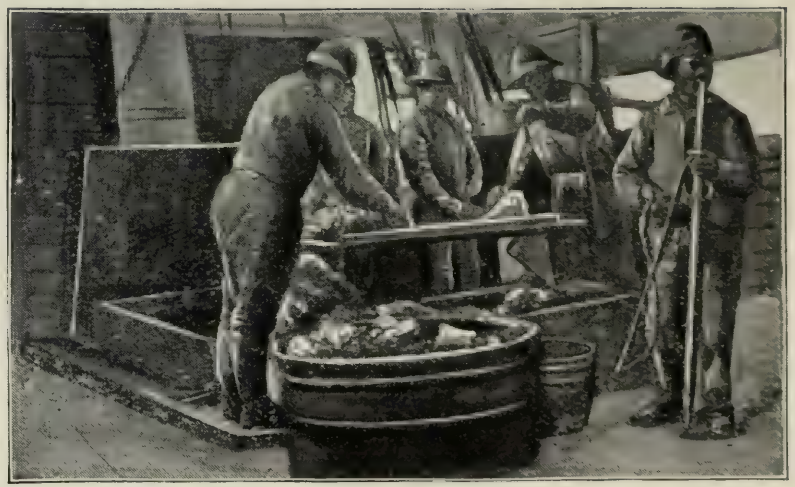
The operation of cutting-in the whale lasts about an hour, and, after the "head" is removed, is not difficult unless there is a heavy sea rolling. A "fin chain" is fastened around the uppermost fin to start the "blanket pieces." Keen edged cutting spades are used by men standing on a staging suspended over the whale, with which they cut the "blanket pieces" into strips a yard or so wide and separate the blubber from the "lean." This operation is not unlike that of cutting the peel off an orange in strips, and separating it from the pulp by means of a sharp knife. The "blanket pieces" vary in length from twenty to thirty feet, and as each one is cut off it is hoisted on deck and dropped down into the "blubber room" which is the space between decks, between the main-mast and the foremast. As soon as the cutting-in is completed, the work of "boiling" usually begins.

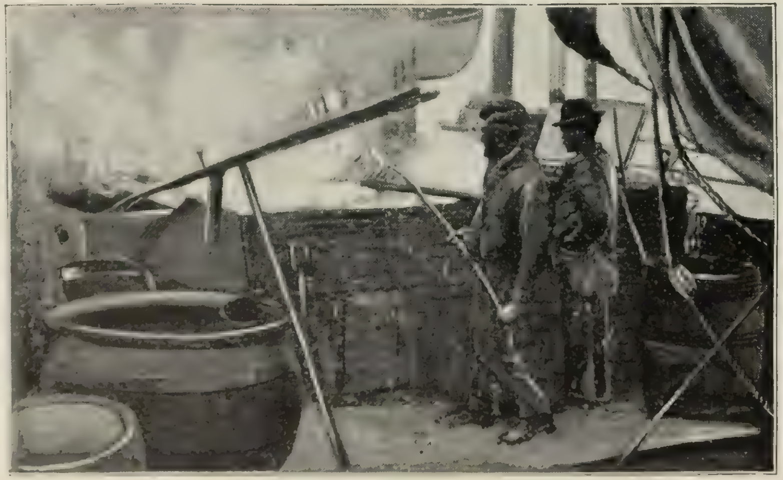
Two or three men go down into the "blubber room" and cut the "blanket pieces" into "horse pieces." These are strips about ten inches square and a yard or so long. These "horse pieces" are in turn "minced," that is, sliced with keen edged "mincing knives," after the manner of cutting a loaf of bread into slices, then they are ready to go into the great deck pots to boil.

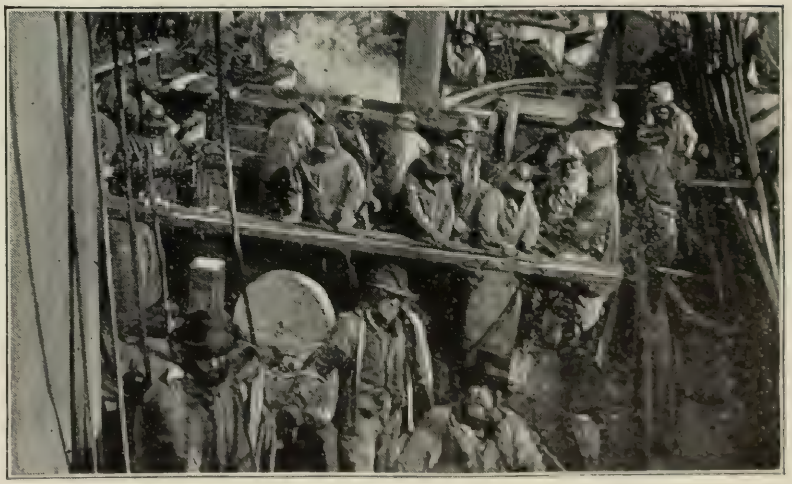
It is like a vision of the infernal regions to see a whaleship "boiling" at night. The only light comes from a "bug-light," a wire basket of a capacity of a bushel or so suspended immediately over the try pots, and filled with "scraps" which are pieces of blubber from which the oil has been tried out, and which have been skimmed from the deck pots, and perhaps been put through a press to still further extract the oil from them. The "bug-light" flickers in a most lurid way, and gives the whole scene a weird and uncanny appearance.

Standing above this scene on the quarter deck and looking down upon it under the glow of the light, one can readily imagine himself in the nether regions of darkness. In the foreground are the men who









SCENE ON DECK DURING "TRYING-OUT."

TENDING THE TRY POTS.

MINCING THE BLUBBER.

DECK SCENE WHEN WASHING WHALEBONE.

do the mincing, cutting away monotonously, and perhaps to the rhythm of a subdued song. Another man is hurrying to and fro carrying the minced blubber to the try pots. Two men tend the pots, and at short intervals reach into the darkness for what appear to be huge pitchforks similar to that which His Satanic Majesty is represented as wielding. With these they reach far down into the pots, and stir up the oil, then raise them high into the air toward the "bug-light," and examine closely suspicious looking objects dangling from them.

Then they open the doors to the fire chambers and shovel in "scraps" to feed the fire. There is a rush and a roar of flame which lights up their besmutted faces, and which crackles fiendishly. And as the doors are closed again, a cloud of foul smelling black smoke pours from the stacks, dimming the illumination of the blazing "bug-light," settling all over the deck, and penetrating into the inmost corners of the cabins.

It is a glimpse of the lower regions more vivid than Dante could describe or Doré depict.

Every year brings a gradual disappearance of much of the excitement and the picturesqueness in whaling. Just as steam, armor plate, and big guns have made modern war vessels mere engines of destruction that have no grace and have displaced human courage and skill with human machines, so steam and powerful explosives are making whaleships into mere whale-killing machines.

The rugged character and sterling seamanship of the whalemen of years gone by was due to the fact that the ranks were recruited from some of the best blood of New England. But this has all changed, and this industry which once offered rapid promotion and early fortune, now offers but an uncertain and precarious livelihood.

Half a century ago the whaling service was one of the great civilizing agencies. It opened the way for missionaries to Christianize fierce and cannibalistic tribes, and for traders and settlers to teach them the vocations and arts of civilized communities. It gave us illumination for our homes and our light-houses; it lubricated the wheels of industry, and in the trying time of war it manned the vessels of our navy with their bravest and most efficient seamen.

Now the whaleman is no longer an important factor in the industrial world. All corners of the seas have been explored. The low price of oil would have retired years ago every vessel engaged in the fishery had it not been for the stimulating effect of the steadily increasing price of whalebone. But the supply of bone is far too small to satisfy the demand, and the price for what there is in the market is so high that it is only a question of time when some substitute will be discovered that shall displace it.

THE GREAT DAM AT AUSTIN, TEXAS.

By Frank E. Snyder, C. E.

TEXAS can well lay claim to the "Second Niagara," in the falls created by the great dam in the Colorado river at Austin. The river just above Austin emerges from between high hills, having traversed a distance of over 400 miles from its head-waters. Spanning this cañon the city of Austin has built one of the largest masonry dams in the world. The clear length of spillway reaches 1090 feet,—head gates and bulkheads 270 feet—a total length over all ot 1360 feet; height from foundation to crest 68 feet, raising the water 60 feet above low-water mark. The one thing making this dam notable above other large masonry dams is not its great size alone, but that it spans a large river subject to tremendous floods, when the dam will have to pass a depth of 15 feet of water over its crest.

The utilization of the power of this stream by the city of Austin had long been agitated and was finally brought before the city government in a message by the mayor, Mr. John McDonald, early in 1890, resulting in the selection of an engineer—Mr. Jos. P. Frizell, M. Am. Soc. C. E., of Boston, Mass.,—to examine and report on the project. Mr. Frizell's report was presented in March, 1890, supplemented by a report from Mr. John Bogart, State Engineer of New York, as consulting engineer. Both reports favored a 60-feet dam as best suited to the location and to the development of power for the operation of an electrical and waterworks plant for the city, and to have reserve power for manufacturing plants. The estimated cost was $1,400,000.

Funds were at once voted, and a board of public works created to handle the work, which was begun in November, 1890.

Mr. Frizell had prepared the plans and was appointed chief engineer. The construction of the dam alone occupied 2½ years. It cost $611,000. The first illustration shows the completed dam as the last stone was being set on May 2, 1893. The overhead cableway for transporting all the material, designed by the Lidgerwood Company of New York, and which occasioned much comment as to its efficient work, is shown in the cut. The blocks of masonry were hoisted from the cars, carried, and lowered directly into position in the dam by means of this cable.

Texas has an inexhaustible supply of granite in the quarries near Austin,—the same from which the Texas State Capitol was built some years ago. This granite was used for both faces of the dam and the core was made from limestone quarried right at the dam. The total quantities used were 20,650 cubic yards granite, and 70,650 cubic yards limestone masonry. The whole work was laid with Portland cement mortar.

The lake formed by this dam is 25 miles long, covering an area of 2000 acres.

Estimating the available water power Mr. Frizell reported the following: "The drainage basin of the Colorado above Austin is some 40,000 square miles in area. It lies between the parallels 30 and 34. Snow rarely falls, and there is no distinctly rainy season The average annual rainfall of the basin so far as I can learn is 25 inches. . . . . The river is subject to great rises in times of heavy rains. On the cessation of the rains it falls rapidly until it attains a minimum flow which appears to remain nearly constant. . . . . This flow is nearly 1000 cubic feet per second. Upon this flow the total amount of power available for driving machinery equals 5227 horse-powers constantly."

For the 60 working hours of the week Mr. Frizell estimates 14,000 horse-powers available per day of 10 hours.

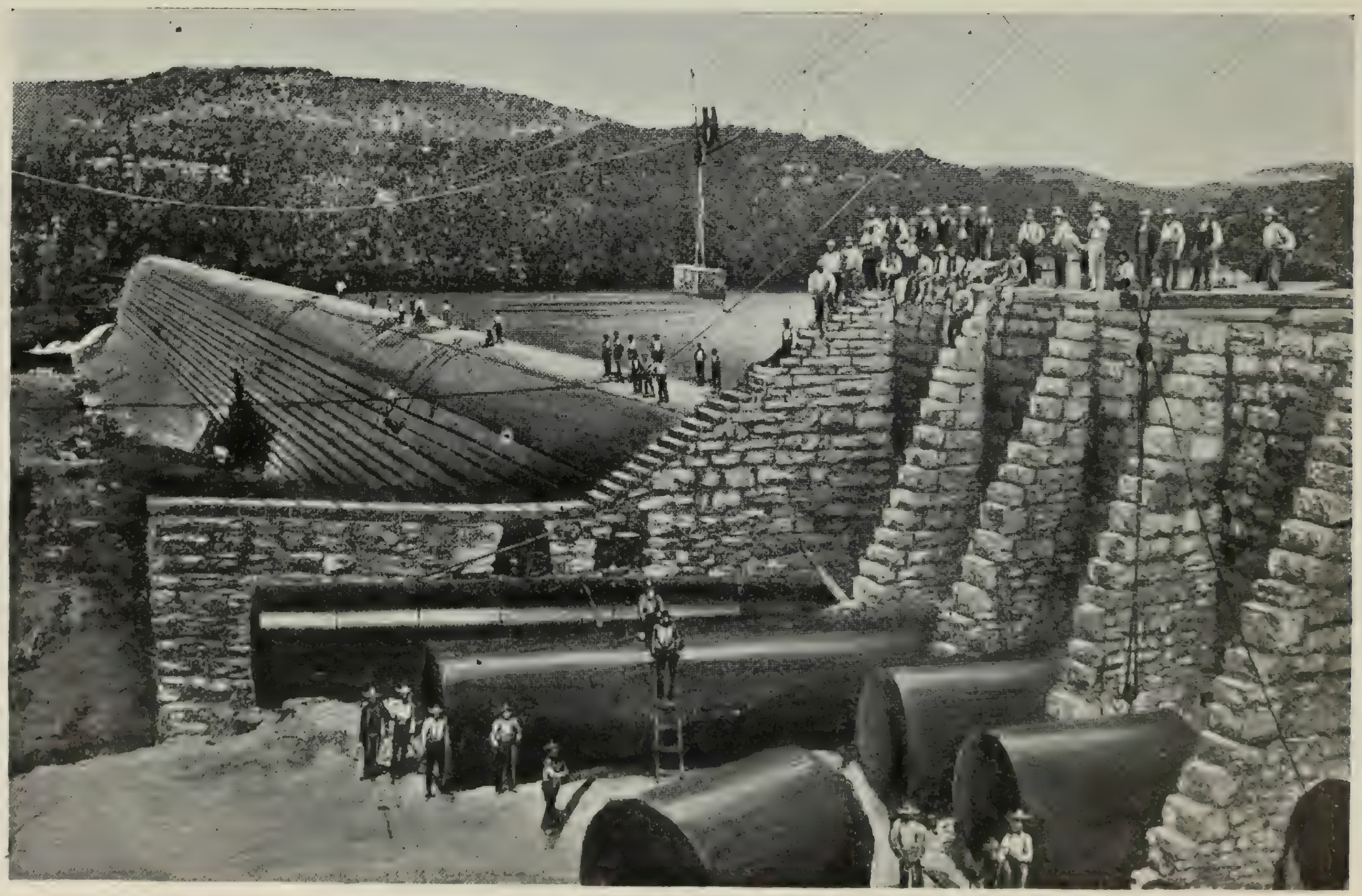
Mr. J. T. Fanning, M. Am. Soc. C. E., reporting on this same work estimated that the city would have a surplus power, above that required for its own service in electrical work and waterworks, of 3950 horse-power or something over 9000 horse-power for the 10 working hours of the day.

Commenting on the amount of work this represents, Mr. Fanning quotes as follows:

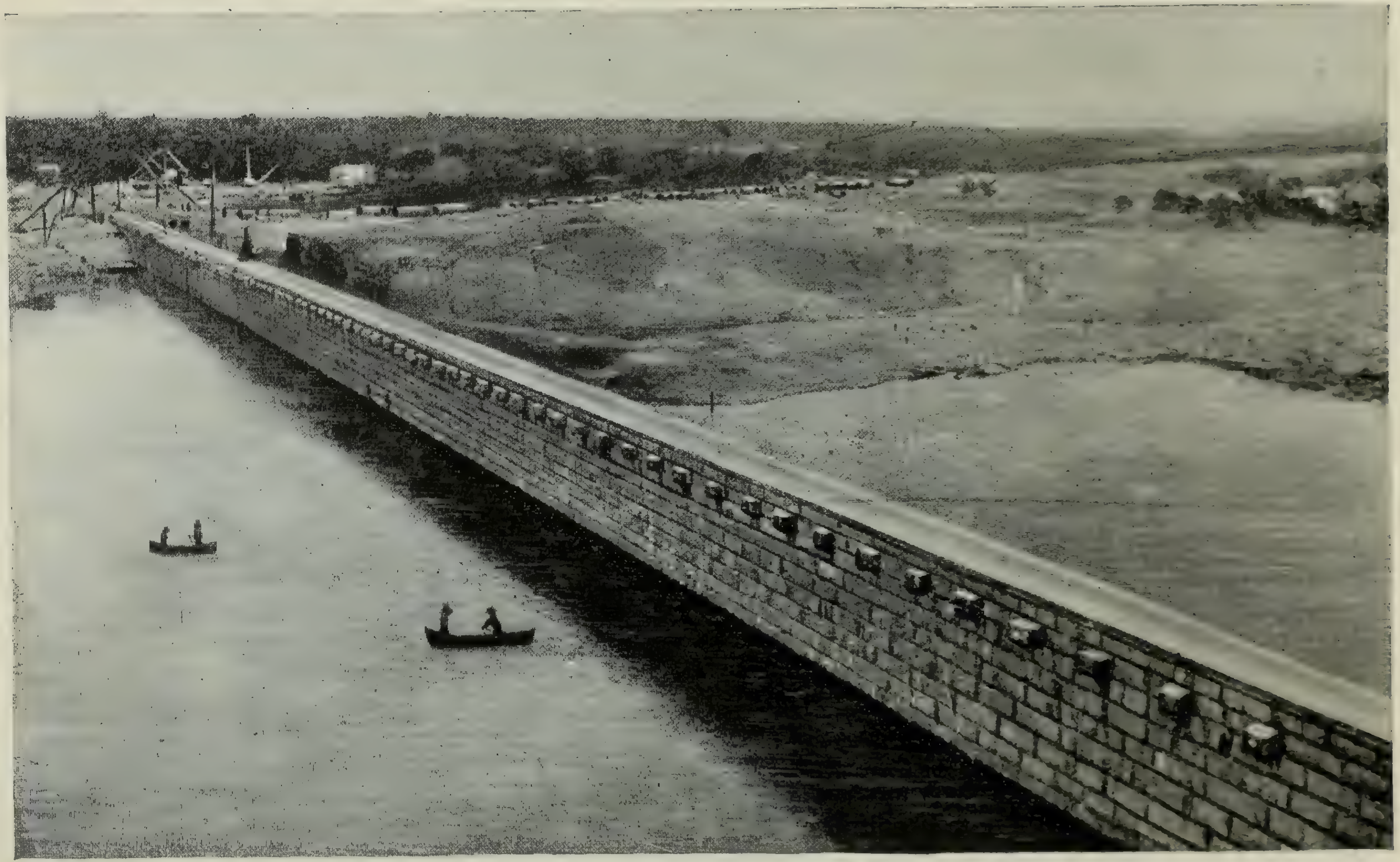
"One hundred horse-power is sufficient for a large machine or implement shop; 450 horse-power will run a cotton mill with 50,000 spindles on cloths adapted to the local jobbing trade, and 400 horse-power will run a wheat flour mill of 1000 barrels capacity, or an equivalent corn meal mill."

The power plant now being erected for the city is situated immediately below the head gates on the east bank or city side of the river. Seven iron penstocks, 9 feet in diameter are set in the head gate masonry to convey the water to the wheels. The water is controlled by large sliding gates, working in vertical guides, operated from the top of the wall. Four of these penstocks will be used by the city of Austin, leaving three to be used for private industries.

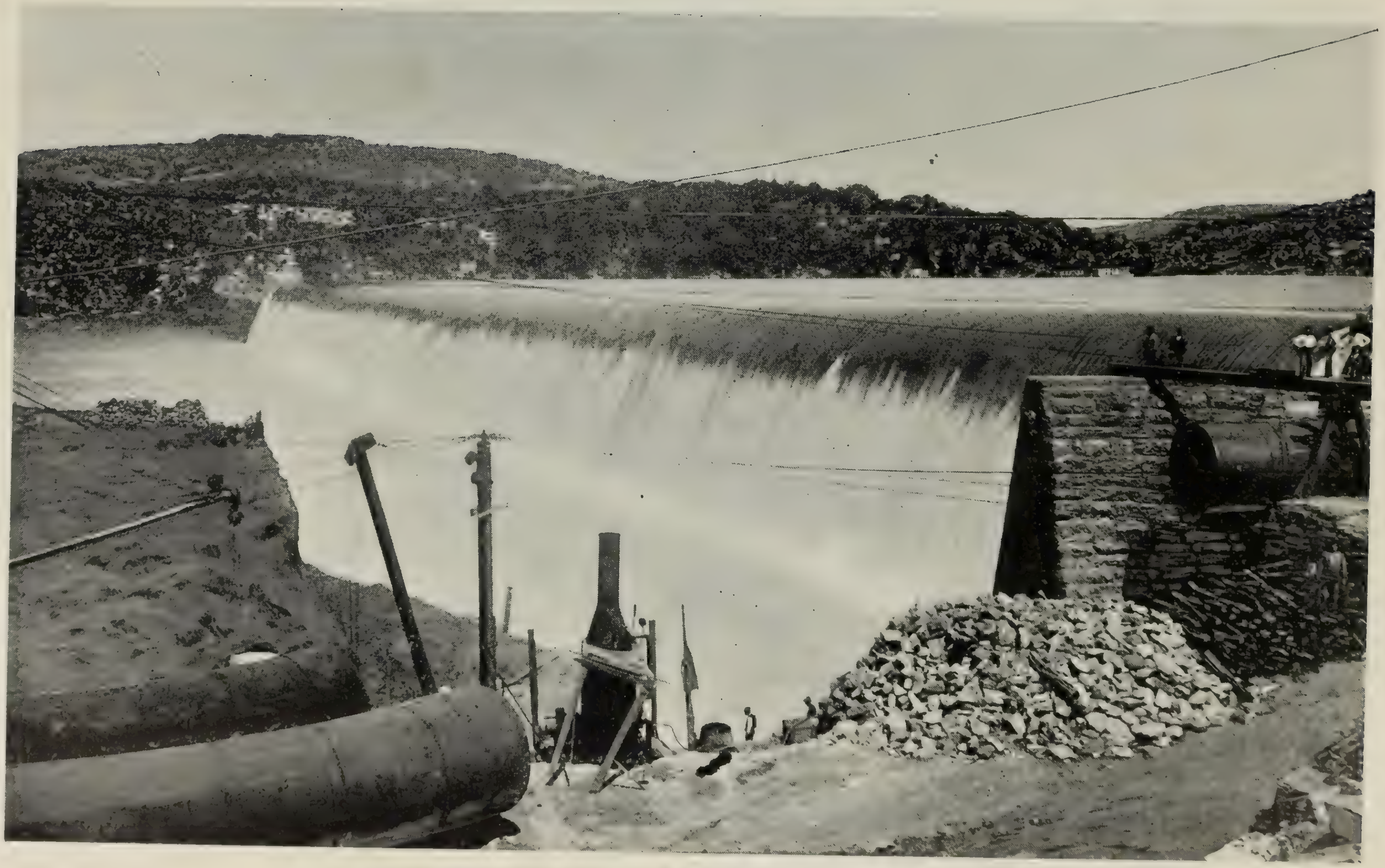
This plant when complete will be one of the largest in the southwest. There are two vertical turbines and four pairs horizontal turbines aggregating nearly 2500 horse-power. The vertical wheels will drive the pumps, and the horizontal wheels the electrical machinery. The waterworks system comprises about 30 miles of mains, being supplied by two 4,000,000 gallon pumps. The electrical plant supplies a



LOOKING NORTHWEST—SETTING THE LAST STONE.



THE UP-STREAM FACE.



DAM AT AUSTIN, TEXAS. 3.7 FEET OVER CREST, JUNE 3, 1894.

street lighting system of two-hundred 2000-candle power lights, with a reserve power sufficient for 15,000 16-candle power incandescent lights, and an aggregate of 500 electrical horse-power for motor and street railway work.

The completion of the power plant was delayed about a year by a serious break in the eastern bank of the river encompassing part of the power house site, and breaking down part of the head gate masonry. This has been rebuilt, and it is expected to have the plant in operation in a few months. The break was due to a fault in the limestone bluff into which the head gate masonry abutted.

The city issued and sold $1,400,000 worth of 5 per cent. bonds to build this work. The estimated annual revenue is put at about $150,000, when in operation.

Commenting on the influence which this water power would have on this district and Austin, Mr. Fanning quotes the following: "Central Texas is now entering an industrial era. I read that the recent geological surveys show several large areas in the state to be rich in minerals, including coal, copper, galena, silver and certain valuable mineral earths; and these will give a new direction to local energies and investments. The rich ores may be here treated electrolytically by aid of this water power. . . . . Austin is in the heart of a rich belt where raw products can be economically supplied in almost inexhaustible abundance if a market is assured for them through this mechanical line. . . . . This great water power is worth its cost for pumping the city water supply and giving the power for the city's electrical works." Mr. Fanning is the present consulting engineer and Mr. Jos. Kepferle, engineer in charge of the work.

The lake, named "Lake McDonald" in honor of the mayor and president of the board of public works, has become quite well known for its aquatic facilities, an international regatta having been held here in 1893 and 1894, at which were all the famous oarsmen of the world, some records being broken by the time made on this course. The lake is equipped with large steamers, and the place is becoming well known as Texas' Chautauqua.

THE WORLD'S GOLD PRODUCTION.

By T. A. Rickard, F. G. S.

IN a former number of this Magazine * the writer endeavored to prove, by a reference to statistics and other facts, that the difficulty of winning gold was, owing to the exhaustion of the more shallow and more accessible deposits, daily becoming greater. Since the preparation of that contribution much has been written regarding the sources of the world's gold supply. The subject is one of particular moment not only to that small and energetic fraction of the community engaged in mining but also to that far greater and ever-increasing number of persons to whom it is evident that the future well-being and prosperity of this and other countries depend upon the right solution of the great problem of our time—the monetary question.

The collapse in the market value of silver which took place in June, 1893, caused a check to all mining enterprise, a check which was however temporary in so far as it affected the search for metals other than silver and was followed by an increased activity in the winning of that metal whose value events had not depreciated but rather enhanced. The marked impulse thus given to gold mining has put a vitality into the industry which has led to increased exploitation in old districts and to renewed exploration in undeveloped regions. The results are already made manifest by the figures which give the yield of gold for 1893.

The director of the United States mint gives the world's production in 1893 as 234,006 kilos or 7,523,362 ounces, valued at $155,521,700. The figures for the previous year are stated to be 220,133 kilos or 7,077,146 ounces, valued at $146,297,600. The amount credited to 1892 by Mr. R. E. Preston—the new director of the mint—is considerably greater than that given by Mr. E. O. Leech, the former director. The difference is largely due to the fact that the former does, and the latter does not, include China among the gold producing countries. Mr. Preston estimates China's production in 1892 at 12,678 kilos of a value of $8,426,039.

According to the most recent statistics the production of the world during the last three years has been:

1891..........	196,586	kilos valued at	$130,650,000
1892..........	220,133	" " "	146,297,600
1893..........	234,006	" " "	155,521,700

In his latest report the director of the mint comments upon these figures and points out that the value of the gold product in 1893 was only 8.77 per cent. less than the average aggregate value of the gold and silver produced in the years 1861 to 1865, which Dr. Soetbeer estimated at $170,473,383. It may be pointed out however that in the year 1853 the world's output of gold was no less than that for 1893. Mr. Preston expects the yield for 1894 to reach about $190,000,000, an amount equal to the value of the world's production of both metals, gold and silver, twenty years ago. The average annual production of gold and silver was, according to Soetbeer, as follows:

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* December, 1893.

1856–1860....	Gold	201,750 kilos.	Silver	904,990 kilos.
1861–1865....	“	185,057 “	“	1,101,150 “
1866–1870....	“	173,904 “	“	1,969,425 “

while in 1893 according to the mint report the gold produced was 234,006 kilos, and the silver, 5,002,294 kilos. These figures prove that the comparison made by the director between the gold of 1893 and the gold plus silver of twenty years ago owes its interest mainly to the fact that the silver production has enormously increased and not so much to the decrease in gold production.

This fact he considers must exert a powerful influence on the monetary policy of all civilized communities. Continuing this line of thought he estimates the *minimum* value of the world's output of gold in 1895 at $183,842,000 and in 1896 at $200,000,000.

The director of the mint therefore confirms the idea which is prevalent to the effect that the production of gold not only locally but also generally the world over is destined to a marked increase, an increase so great as to play a serious part in the determination of the choice of a monetary standard. Expression has been given to this idea in many organs of public opinion. The writer's knowledge of the conditions of the gold mining industry in the regions which are the chief contributors to the world's supply leads him to believe that such an idea is unwarranted by the experience of the past and opposed to the facts as they exist to-day.

A brief reference to the four leading gold producing countries will be required before further discussion.

The United States during the last three years has produced gold as follows:

1891...........	1,604,840 ounces.	$33,175,000
1892...........	1,597,098	33,014,981
1893...........	1,739,700	35,959,599

In 1893 the chief increase came from Colorado, which produced $7,525,000 as against $5,300,000 in 1892. The production for 1894 will undoubtedly show a further increase. That increase will prove a very important factor in advancing the prosperity of the state, but it will in no way be of such magnitude as to be of any moment in augmenting the world's production or in influencing the course of financial legislation. Much has been made of the extraordinary growth of the amounts of gold deposited at the Denver mint. It is not generally known that two of the large smelting establishments which formerly forwarded their bullion to the east to be refined now send it to the Denver mint. This is an example of the way in which statistics can prove misleading.

From 1848 until 1893 California has held the first position among the gold mining regions of America. At the present time Colorado bids fair to surpass the golden state. For the last four or five years the yield of California has been practically stationary at 12 to 12½ millions. In 1893 there was no noteworthy increase. Much has been said by fervid Pacific coast writers regarding the enormous increase in the gold yield which would result from the reopening and operation of the large alluvial mines (worked by the hydraulic process) which had been closed down on account of débris legislation and were to be restarted under the Caminetti Act. It was stated that the resumption of work would add from $15,000,000 to $25,000,000 to the production. As a matter of fact statistics show that the closing down of the alluvial mines of the Sierra Nevada decreased California's yield from 6 to 8 millions per annum.

The passage of the Caminetti Act has not sufficed to thoroughly reanimate alluvial mining in California. It will not serve to do so. The margin of profit in the carrying on of operations and the difficulty which yet exists on account of the terms of the Act are the one so small and the other so great as to prevent the full resumption of work.

Only a few mines have resumed operations. The building of impounding dams—required by the new law—is in very many cases, owing to the topography, impossible. In other instances the mines do not warrant nor have the owners the means to justify the incurring of such an expenditure. On the whole, therefore, it is safe to say that it is extremely improbable that California's gold output will, either now or in the near future, be seriously assisted by the output of the alluvial mines which were closed down in the years succeeding 1882.

While the days of extensive alluvial mining are on the wane, vein mining is characterized in California by the prosperity which follows upon successful development. But in this instance, as is the case elsewhere, the yield of the new mines is barely able to compensate for the exhaustion of the old ones, and there is no such lavish output as characterized the days of placer mining on the Yuba and American rivers.

In the other states of the Union where gold mining is carried on—

Dakota, Montana, Idaho, Arizona, etc.,—there is a prospect of increased activity which will compensate for the diminution in the yield caused by the closing down of silver mines which also produced gold. In a general way it is certain that there is in the United States to-day a noteworthy increase in the search for gold; this is manifested in the reworking of abandoned placers, the reopening of old mines and an active prospecting whether for alluvium or veins. The results of this activity are exaggerated. The ordinary local newspaper may talk in a manner half poetic and half hysteric of the "boom" in its own section. These things are of small moment. In most cases the increased work on gold producing mines will barely compensate for the loss in the total yield due to the cessation of work in properties which formerly produced both gold and silver. The temporary renewal of activity often only means the nearer approach of a complete exhaustion of surface gravel and shallow deposits of every kind.

The gold mining industry of the United States is destined to a future of great usefulness and ever-increasing economic importance, but the writer does not believe that the average annual production for the next ten years will much exceed the average of the last decade.

Australasia was the largest gold producer of the world in 1892 and 1893. Last year the output amounted to 1,876,562 ounces valued* at $35,654,678. These figures indicate an increase of 80,432 ounces or $1,528,208 over 1892. Of the total increase no less than 51,342 ounces is to be attributed to Western Australia, a country which until recently has been the most backward and least developed of all the colonies. The output of Victoria, which is to Australasia what California is to America, increased from 654,456 ounces to 671,125 ounces. Queensland and New South Wales exhibit a slight increase while South Australia, Tasmania and New Zealand produced less than in 1892.

There is no reason to anticipate any noteworthy increase in the production of these colonies. The discoveries made during the past twelve months at Coolgardie, Southern Cross, and other new camps situated amid the desert lands of Western Australia are not of such a character as to have more than a local importance. Their development will always be hindered by great natural obstacles, the chief of which are the want of water and the scarcity of mining timber. The increase in the production of Western Australia which will follow from the working of the most accessible surface deposits will be barely sufficient to balance the decreased output of the more important colonies.

In Victoria the deep mines of Bendigo † are not doing so well this year as in 1893. The rich finds recently made near Daylesford and the discoveries of alluvial ground at Huntly, Wedderburn and elsewhere will scarcely offset the gradual exhaustion of the deep leads of Creswick and Ballarat. In New South Wales some discoveries have recently been made, as the result of increased activity in prospecting, but they are not of far-reaching importance.

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*I estimate the value per ounce at an average of $19.

† Bendigo has 27 vertical shafts exceeding 2000 ft. in depth. The "180" mine is 3100 ft. deep.

The mining industry of the colonies is in a healthy and vigorous condition ; the injury done to silver mining at Broken Hill by the collapse in the price of the white metal will be balanced by renewed energy in gold mining ; but this again, while important to the country itself, will not be such as to play any important part in the world's business.

Russia produced 38,822 kilos or 1,247,156 ounces, valued at $25,801,645, in 1892. The figures of the output for last year are not yet available.

It is very probable that Russia's annual yield will begin to decline in the near future. Such a statement is based on the fact that the center of placer mining has been moving steadily eastward, from the Ural mountains to the coast of the Pacific. The first discoveries were made at Ekaterinborg in the Urals, and operations have been gradually extended eastward as new districts have been successively discovered, developed, and exhausted. The bulk of the yield of the Russian empire now comes from the Amoor river, from Nerchinsk and other districts in the remote eastern provinces of Siberia. The mines in the Urals, the diggings on the Yenesei, those on the Olekma, have each in turn been the scene of greatest productiveness and each in turn has given place to some newly found region further from Europe. As was said by Striedter more than ten years ago—" the sea is set as a barrier to the further migration of the production of gold."

But, it may be objected, surely with the rapid improvement in gold extraction new methods will render available the old abandoned diggings. Prof. Suess has pointed out that the reworking of the tailings of the old mines by the aid of improved processes and greater technical knowledge is not to be relied upon for any considerable addition to the production. It is too late to introduce them, as has often been found out by enthusiasts in this and other countries, when the gravel has once been turned over.

There are therefore no facts which warrant the expectation that Russia will be able in the coming decade to add to the average of her present annual output.

Africa, the new El Dorado of the south, remains to be considered. In 1893 the output of the Witwatersrandt in the Transvaal amounted to 1,478,477 ounces, while the total output of South Africa was 1,610,-

046 ounces, which, taking the gold at 850 fine, gives a value of $28,272,407.

The increase over 1892—equal to a money value of about six million dollars—was due almost entirely to the mines of the district of which the town of Johannesberg is the center. This region contains a series of beds of gold-bearing conglomerate—called banket reefs—which have been developed with extraordinary rapidity during the past five years. In 1893 certain bore holes were put down with the aid of the diamond drill and the continuity of the deposits was proved by the discovery of gold-bearing material at a depth of 2400 feet. The increase in the year's output amounted to 267,610 ounces. For the first six months of 1894 the yield has been 973,736 ounces or 779,000 fine ounces, an increase of 46.4 per cent. over the same period last year. At this rate the output for the present year will reach 1,600,000 fine ounces.

If the world's gold production is to undergo an increase such as is predicted by the director of the mint and other authorities, then South Africa will be the region from which this increase may be expected. But, while in no way underrating the marvelous growth of the mining industry of the Randt and thoroughly appreciating the enormous extent of gold-bearing territory which there exists, the writer believes that, as has been the case many a time in other newly developed districts, the estimates formed have been too much tinged with that sanguine spirit which must ever characterize successful mining, but which must be eliminated in the study of statistics. The following figures will be of value:

Year.	*Tons produced.*	*Gold yield.*	*Average per ton—dwts.*
1887		23,155	
1888		208,121	22.65
1889		369,557	19.60
1890	702,828	494,817	13.36
1891	1,154,145	729,238	11.23
1892	1,979,354	1,210,867	10.20
1893	2,217,843	1,478,477	10.09

The above statement, while it forcibly illustrates the great growth of the output, also emphasizes the fact that the yield per ton is decreasing. In May, 1894, the output was 115,466 ozs. 4 dwts.* from the treatment of 243,217 tons, giving an average yield of 9.5 dwts. per ton. It will be noted that the average yield as above given does not agree with the tonnage and total gold production. This is due to the fact that the extraction of gold from accumulations of old tailings has added very considerably to the output. Thirty per cent. of the yield of the Witwatersrandt comes from the treatment of tailings by the cyanide process. This source of production is very limited.

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* Plates and concentrates. The tailings are excluded.

The steady decrease in the yield is due to the exhaustion of the bodies of higher grade free milling ore occurring near the surface. As depth is gained the ore becomes pyritic, its gold contents tend to decrease and the cost of its reduction in the mills tends to augment. The Robinson mine in 1893 treated 94,842 tons of ore and produced, excluding tailings, 114,882 ozs. 15 dwts. of gold. These figures are exceptional. The character of the mining of the region is better indicated by the results achieved by the Langlaagte estate and Crown Reef companies. The former obtained 74,860 ozs. 3 dwts. from 222,732 tons, giving an average of 6.7 dwts. per ton. The latter obtained 52,411 ozs. 2 dwts. from 118,244 tons, giving an average of 8.8 dwts. per ton.

The great increase in the output during the past three years is traceable to the erection of new and large mills; it is also due to the successful treatment of accumulations of old tailings which owing to the bad milling of the early years are so rich as to make them profitable of treatment now. Both these factors will shortly cease to operate, a halt will be called in the erection of new mills and the tailings heaps will become exhausted. In the meantime the steady operation of the mines will be followed by the working out of the upper levels with their less refractory and better ore, leaving for the future the enormous masses of low-grade pyritic material. As the mill treatment has been improved lower-grade ores have been made available, but it is probable that the figures quoted from the Langlaagte and Crown Reef mines give the limit in this direction. It is true both these properties paid handsome dividends in 1893 but this was largely due to the 30,050 ounces and 29,679 ounces which they respectively obtained from old tailings.

The conclusion to be arrived at is an old one—"qui va piano va sano." South Africa will repeat the story of other mining districts, it will be an important gold producer, probably within a couple of years it will reach the first position (it has already surpassed Russia); but there is no reason to suppose that the phenomenal growth of its production will go on in arithmetical progression indefinitely, as many authorities would suggest. Its yield will serve to counterbalance the exhaustion of older regions but it will not have the economic importance of the early Californian and Australian discoveries. In 1851 California produced $81,294,700 after three years' development, in 1853 Australia yielded $62,001,761 after two years' development, in 1893 South Africa gave $28,272,407 after 6 years' vigorous and systematic work. It cost more to produce the 28 million dollars' worth of South African gold than it did to obtain the 143 millions yielded by California and Australia in the two years quoted. The explanation lies in the fact that South Africa has no large deposits of rich easily accessible alluvium.

The alluvium of the world is being rapidly removed, like the cream off a pot of milk. In the years between 1848 and 1875 no less than 87.78 per cent. of the gold of the world came, according to Professor Suess, from alluvium. I would estimate that in 1893 not more than 35 per cent. came from this source.

Those who talk enthusiastically of the activity in gold mining and of the enormous yield which is to come from that activity in the ten or twenty years that are to come should remember that Europe was once the great gold producing country of the world, that Dacia (now Transylvania) was a golden storehouse to the Romans ,and that in an earlier age Hannibal got the sinews. of war from the gold mines of Spain. Where are they now? The former contribute a driblet, the latter are a tale in history.

Statisticians may sit at their desks and discourse entertainingly with the figures which are before them as a text; but the mining engineer who has been to the places where those figures are created knows full well that Ichabod is written over many a gold mining region which the statistician fondly imagines will continue indefinitely to add to the world's store of the yellow metal.

ADVANTAGES OF THE TEHUANTEPEC INTER-OCEANIC ROUTE.

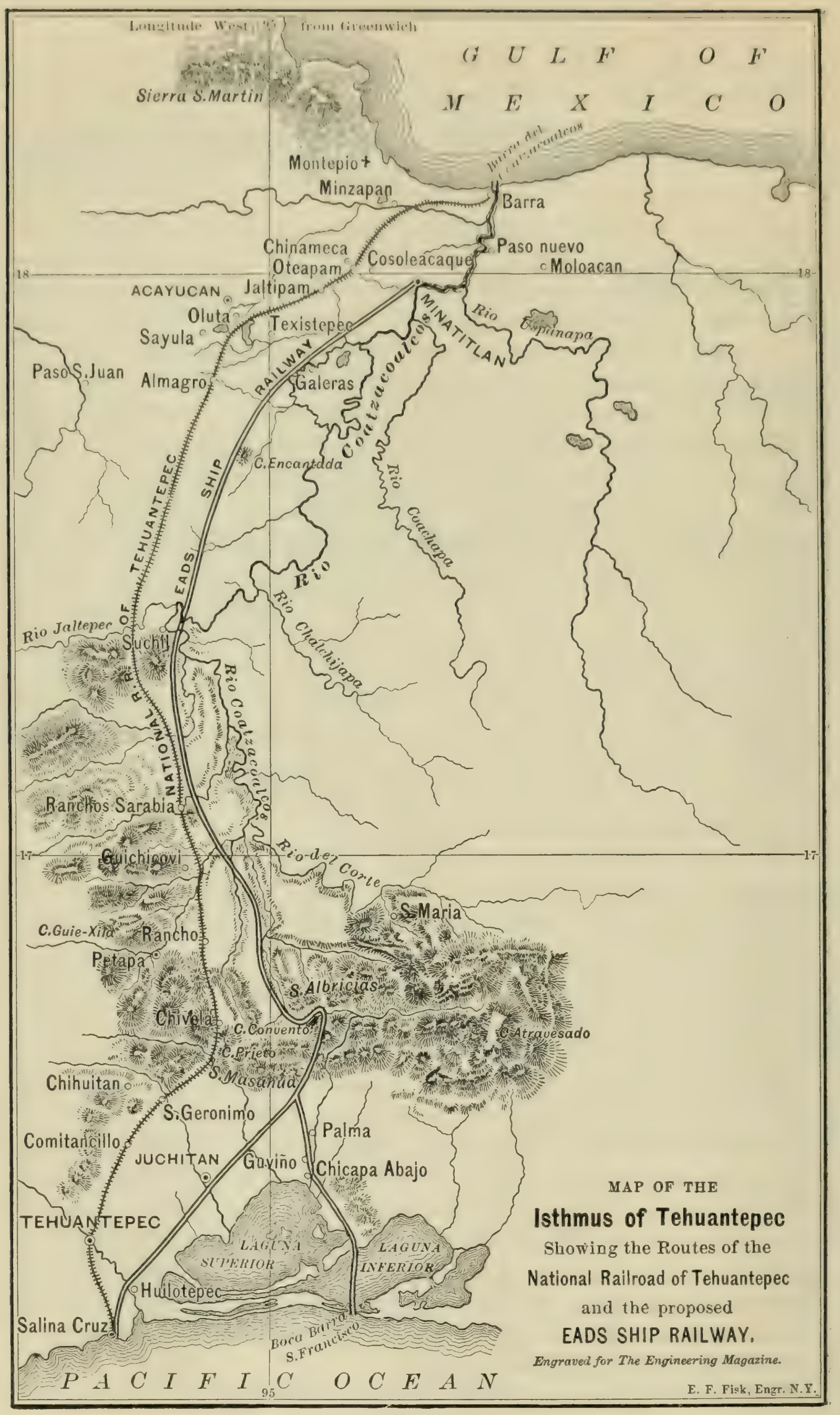
By Elmer L. Corthell.

FIFTEEN years ago, upon the sea end of the East jetty, extending into the Gulf of Mexico at the mouth of the Mississippi, the man who had conceived and successfully executed this great work stood one day watching the passing ships. The bar, on which there had been only eight feet of water, had, at his command, yielded to the current forces and had gone out into the depths of the gulf, through a splendid navigable channel, sufficient for the largest ocean-vessels. Turning from these ships and looking out across the gulf he saw in imagination a low-lying land, 800 miles distant, and beyond it the waters of the great Pacific. Awaking as from a reverie he said to the writer: "We must next discharge the commercial volume of the Mississippi into the Pacific ocean." Then eight years of Captain Eads's life were given to the stupendous task of conceiving and executing the plans for this work, and of convincing the civilized world that ships could be taken overland from ocean to ocean. On his death-bed almost his last words were, "I cannot die; I have not finished my work." But his project did not die with him; it is waiting for another great genius and the proper time.

The other isthmian projects, which Captain Eads combatted and the failure of which he predicted, have come to grief already. It is not intended here to combat either of them, but simply to state the conditions, advantages, and entire feasibility of the Tehuantepec isthmus as a railway route, in the belief that the statement of the facts will be enough to prove the wisdom of President Diaz, of Mexico, in taxing the resources of his country to open here an interoceanic route.

Mr. Matias Romero, in the March number of this Magazine, has skillfully drawn the outlines and filled in one corner of the picture—that part which relates to the efforts since the time of Cortes to find a pathway at Tehuantepec for the commerce of the world. The present writer proposes to fill in the remaining details and endeavor to make the picture complete and in harmony with that strong and growing sentiment of this and other countries demanding the best possible method of interchange of the world's products, across the American isthmus, and particularly of connecting the eastern and western coasts of the United States via the isthmus.

The table of distances presented by Mr. Romero is so complete



MAP OF THE

Isthmus of Tehuantepec

Showing the Routes of the

National Railroad of Tehuantepec

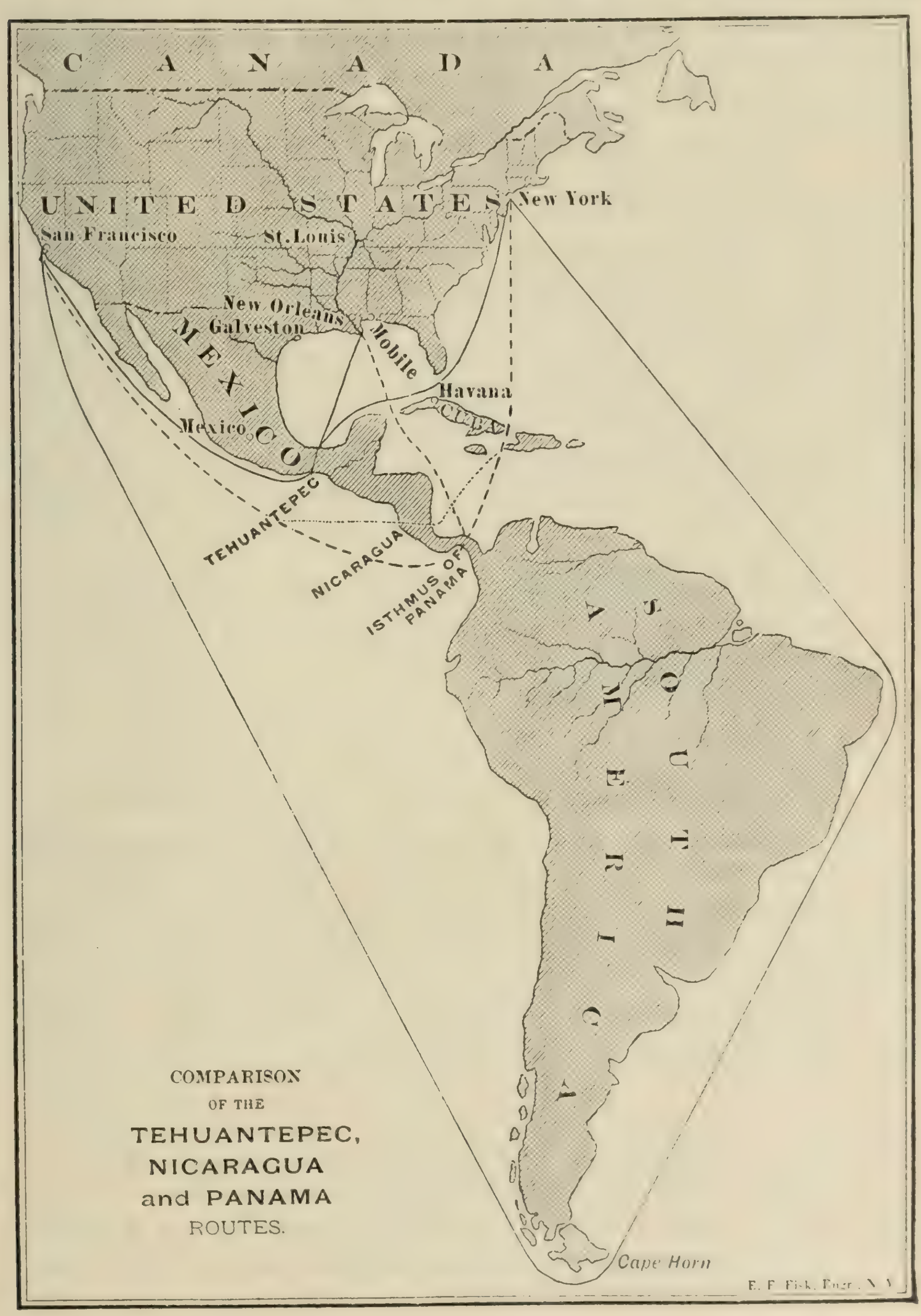
and the proposed

EADS SHIP RAILWAY.

Engraved for The Engineering Magazine.

E. F. Fisk, Engr. N.Y.

that the reader can by comparison see how much shorter is the Tehuantepec route as compared with other isthmian routes, but a study of the geographical features of this route, as well as of those around the southern extremity of South America, can best be made by means of an accompanying vignette map of the western hemisphere. By


COMPARISON
OF THE
TEHUANTEPEC,
NICARAGUA
and PANAMA
ROUTES.

noting the trend of shores and continents he will discover that all lines leading from any point on the Pacific coast of the American isthmus by the shortest route to those countries lying along what Mr. Romero calls the "axial line of the world's commerce," will pass directly in front of the harbor at Tehuantepec. The delusive maps which in our childhood taught us the shape of the earth and the relations of the countries to each other would lead us to suppose that the shortest line between San Francisco and Yokohama or Hongkong is a line apparently parallel to the equator, whereas the shortest line, by nearly 500 miles, is the one that passes across the Pacific nearly up to the Aleutian islands near Bering straits. The trend of the entire Mexican and Central American coast on the Pacific follows quite closely the shortest great circle between Panama and Asiatic ports, so that the Tehuantepec port on the Pacific has the advantage of the entire distance between it and Panama,—over 1200 miles,—saying nothing of the additional advantage on the Atlantic side by being much nearer to the ports of the Gulf of Mexico, the Atlantic coast of the United States, and western Europe. Supplementing Mr. Romero's table there is given below the *excess* distance of Panama over Tehuantepec in statute miles, in respect to some of the principal ports to be affected by an interoceanic route:

New York and Hongkong	1048 miles.
New York and Auckland	468 miles.
New York and Melbourne	403 miles.
New York and Honolulu	1139 miles.
New York and San Francisco	1182 miles.
Liverpool and San Francisco	797 miles.
New Orleans and San Francisco	1854 miles.
New Orleans and Auckland	1445 miles.
New Orleans and Honolulu	1980 miles.

The *physical* conditions on the isthmus would require an entire paper to state them. There are doubtless many persons living who, early in the "fifties," under the impulse of the gold fever which took so many to California, made the trip by way of Tehuantepec. A company was organized to build a very good carriage-road (except in the rainy season) through the wilderness and across the plains between the head of navigation on the Coatzacoalcos river and Ventosa, the harbor for the Gulf of Tehuantepec on the Pacific. The pleasantest part of the route was between the gulf and Suchil, about seventy-five miles, along the winding course of the great river Coatzacoalcos, which was navigated by the stern-wheel steamboat *Suchil*. This river for many miles is wide and deep, its banks covered with a luxuriant vegetation and many splendid varieties of forest trees. From Suchil for about thirty-five miles the traveled road at that time, and now the path, lies through a grand and primeval forest, with boughs so thickly interlaced that for miles the sun, even at noonday, is shut out. Here are some of the most valuable woods in the world—the dark mahogany of beautiful grain, the white mahogany, the Spanish cedar, and many other fine woods The writer has often seen a half dozen large vessels at once loading at Minatitlan with mahogany and Spanish cedar for the United States and Europe. Only such of these woods as lie convenient to the navigable water-courses have been cut. Almost every kind of tropical fruit grows on the Atlantic slope of this isthmus, including bananas, plantains, oranges and lemons of the best varieties. There is no better country for coffee, tobacco, rice, and corn.

An interesting climatic feature is the sudden passing from the dense, exuberant vegetation of the Atlantic slope to the plains and the rolling pasture-lands of the Pacific. The climate, the soil, and the trees change entirely and almost instantly after passing the Jumuapa river. between the states of Vera Cruz and Oaxaca. From this point, towards the summit of the isthmus, the country is admirably adapted for grazing, and many great herds of cattle roam over these plains, everywhere so well watered by the mountain streams. After passing Chivela, which is at the head of a valley leading down to the Pacific, the Tehuantepec railroad now runs, through a cañon and the valley of the Verde to the Pacific plains, which for thirty miles are nearly level, with a sandy and clayey soil, with vegetation somewhat stunted, to the city of Tehuantepec on the left bank of the river of that name and thence for a few miles to Salina Cruz, the Pacific terminus of the railway. The rainfall on the isthmus is varied ; on the Pacific slope it is very light and on the Atlantic very heavy.

The accompanying general map of the isthmus shows the route of the projected ship-railway and that of the National railroad, the one starting from the mouth of the Coatzacoalcos river and the other from Minatitlan, about twenty miles up the river. These routes are not common except at one point, near Sarabia, where the railroad in its recent location goes through the pass found by the engineers of Captain Eads and since that time called the "Ship pass." Both have a common terminus at Salina Cruz, although it has been proposed to make a terminus for the ship-railway on the lower lagoon. The ship-railway route to Salina Cruz is 154 miles long, and that of the railroad 190 miles.

Perhaps at this time it will be of interest to describe the engineering features of the railroad, lately completed, in relation to which the efforts made by the Mexican government to furnish the necessary funds have been so fully outlined by Mr. Romero. A carefully written description is to be found in a paper by Mr. Manuel Rivera, C. E., one of the government inspectors on the railway. This paper was offered to the civil engineering division of the International Engineering Congress, at Chicago, but too late for presentation. Following is an abstract from this paper.

The line starts from the Bay of Salina Cruz, in the Gulf of Tehuantepec, on the Pacific, following the windings of a narrow ravine until it reaches the Zuleta pass, when it descends to Tehuantepec, a city of 15,000 inhabitants. Thence, in very easy lines, it passes across the Pacific plains to the foot of the ascent leading to the Chivela plains on the table-lands. Through the Chivela cañon the road is mostly built in solid rock. The lateral cañons, or ravines, are crossed by iron viaducts constructed by the Phenix Bridge Company, of Philadelphia. At Chivela the elevation is 790 feet above the sea-level, but there is a second summit to be overcome in crossing the Sierra de Niza Conejo (crazy rabbit), where the maximum summit is reached, 924 feet above sea-level. The maximum grade up to this point and in fact on the entire line is 2 per cent. and the curvature 200 meters (656 feet) radius, although in order to "join the rails" with as little loss of time as possible and with the least money there are temporary grades of 2 and even 3 per cent. and some few curves of 100 meters (328 feet) radius. The route across the table-lands lies through an ordinary rolling country, the maximum grade of the railroad being about 1.8 per cent. and maximum curvature about 600 feet radius. From the Jumuapa river the road passes through a dense forest for many miles to the Atlantic plains. The maximum grade on this slope is about 1.5 per cent. There are five large rivers to be bridged, the largest being the Jaltepec on the Atlantic slope, one of the chief tributaries of the Coatzacoalcos. The only tunnel on the line is about 300 feet in length. The material for the roadbed is generally good. The cross-ties and other timber were obtained from the United States, those for the Atlantic division coming from Pensacola or Mobile, and those for the Pacific slope from the red-wood forests of Oregon, but a large part of the iron-work was furnished by Great Britain. The rolling-stock is partly American and partly English. Sixty miles from the mouth of the Coatzacoalcos is found suitable limestone rock for harbor-works. At Coatzacoalcos there is a well-arranged and suitable terminal station and yard, the buildings for warehouses and shops being of iron, with corrugated roofs, manufactured in England.

There is no reason why, if some of the temporary sharp curves and grades are improved, which can be done at comparatively small expense, the road should not be operated economically and locomotives haul a train of twenty or twenty-five cars its entire length. The local business on the isthmus will be very considerable after the line is opened, as the richness of the soil and the variety of the products will lead rapidly to the development of the country. Besides the railroad telegraph there is a first-class telegraph line on iron poles across the isthmus—a link in the important cable lines of the Mexican and South American Telegraph Company.

In order to make the railroad valuable as an interoceanic route it will be necessary to improve the two harbors. The terminus on the gulf is at the mouth of the Coatzacoalcos river, which carries to sea for several months of the year a large volume of fresh water. Its watershed is about 6500 square miles. The rainfall is quite regular, in its seasons and in its amount, so that it may be depended upon to give a sufficient velocity for excavating and maintaining a deep channel through the bar in the gulf at the mouth of the river. About five miles below Minatitlan, on the opposite side of the river, the largest tributary, the Uspanapa, discharges into the main river. Below the mouth of this tributary at a point in the straight reach of the river, where the width is about 1000 feet between banks, the average maximum depth on the sections is about 70 feet and the cross sectional area about 40,000 square feet. The magnitude of this river will be appreciated by a comparison of its area of cross-section with that of the South Pass, Mississippi river, which is 24,000 square feet. It may be said that there is inside of the headlands at the mouth of the river a continuous harbor at least ten miles long. In the area immediately at the mouth, and which will be used for harbor purposes, the 30-foot channel is about 1000 feet wide and the 40-foot channel 850 feet. The shore on the left bank of the river at the terminal is nearly straight for about a mile. The river enters the gulf between two headlands, one composed of sand dunes and the other of solid land about 60 feet high. The persistent fresh-water flow excavates a deep channel through the bar at the mouth of the river.

As to the sea forces available for maintenance, their magnitude and constancy may be appreciated by their action on the outer slope of the bar, preventing its advance, although there is poured into the sea by the river during the rainy season, an immense amount of sedimentary matter. This outer slope, if measured on the line of the proposed channel and between the 18-foot and 44-foot curves is about 1 in 100, which is a steeper slope than that of any of the other large rivers along the coast of the Gulf of Mexico, except that of the South Pass of the Mississippi as it existed before the jetties were built. These conditions are very favorable for economical construction and maintenance, since the combined action of the river and the sea, one behind and the other in front eroding the bar, greatly reduces the length of the works and the contents of the prism to be excavated by the currents. The plans proposed contemplate parallel jetties extending 4500 feet from the shore to about 24 feet depth in the gulf; the distance between the jetties to be 800 feet. The material in the permanent structure will be entirely of rock. As this harbor is to be used for a great interoceanic traffic, where the largest class of vessels will enter, a channel less in depth than that at New York or New Orleans should not be considered.

As to the maintenance of these works it is believed that jetties, constructed on the plans adopted—based upon an examination made by the writer of the jetties at the mouth of the Maes, in Holland, where there is at times a much more severe exposure to waves than at any point on the Gulf of Mexico—will be able to withstand the waves from the northers, which blow with great force across the gulf from the Texas coast and are quite persistent during the winter. As the question of the existence of wind or littoral currents for maintenance of the channel and the erosion of the outer slope of the bar is such an important one it should be stated that there is a pronounced and constant sea-current with a velocity of from one to three miles per hour entering the Gulf of Mexico between the peninsula of Yucatan and the island of Cuba; this current hugs the shore line all the way along the concave shore of the main land, past the mouth of the Coatzacoalcos river, Vera Cruz, and Tampico.

An observation of the existing physical conditions justifies the belief that there will be a recession rather than an advance of the bar at Coatzacoalcos. There is now upon this bar about 14½ feet of water, and the depth is well maintained and has little variation. From surveys made by Captain Shufeldt, U. S. N. (1871), by the writer (1881), and by Mr. Ripley (1892), there is shown to have been no advance of this bar into the sea for twenty-one years past. The sea and river forces have been in equilibrium, and the bar has decreased in width about 400 feet. Inside of the harbor it is intended to build a wharf, of creosoted timber and piles or of steel, 2000 feet long, parallel to the shore. The slope of the bank into deep water is so steep that this wharf need not be more than 100 feet wide from the shore line into deep water. It is intended to equip this wharf with the necessary tracks, warehouses, and a complete hydraulic plant for handling freight quickly and economically from the ship to the cars and vice versa.

On the Pacific the harbor works will consist mainly of a breakwater of broken stone coped with concrete blocks. Here the coast forms a succession of beautiful curves, whose arcs range from two to eight miles in length. Between each pair of curves a rocky promontory extends into the ocean. On the west of the curve at Salina Cruz, about three miles in length, the promontory is over 200 feet high and consists of hard durable rock, made up of quartzite, syenite, and porphyry. East of this promontory is a flat area of sandy formation with an elevation of about 15 feet above low water extending along the beach three miles to Ventosa. The sand of this formation is a coarse sharp grit of excellent quality for making concrete. The bottom of the bay seems to be of the same general character as the beach, no rock or clay having been found in the soundings. The slope of the shore under water is quite steep and deep water is therefore near at hand.

As the success of any improvement is largely dependent upon the action of the waves and currents it was gratifying to ascertain that the direction of the waves is almost normal, or at right angles, to the general direction of the coast, no matter from what direction the wind may blow, and that the current is always eastward along the shore. There is a constant surf upon the beach of sufficient magnitude to swamp any small boat except during the prevalence of one of the strong northers of winter, when but little surf exists. It will be necessary, therefore, to form a protected and quiet harbor. All freight must now be put ashore by small lighters, resulting in delay and in expense which is often as great as the entire freight-rate of sailing vessels between San Francisco and Liverpool around Cape Horn. To hope that vessels would lie at a pier in such a sea would be idle, and the expectation that any ordinary pier would stand such wave exposure would meet with early disappointment in the loss of the pier, even should the waves permit its construction.

It is estimated that the jetties and auxiliary works at Coatzacoalcos harbor will cost about $2,250,000, and the proposed terminal wharf and its equipment $360,000, the Salina Cruz breakwater $2,700,000, and the terminal piers and dredging $385,000, making a total for the harbors and terminals of $5,695,000 (gold). The contract for railroad work terminated in September. What it will cost to make the necessary betterments for interoceanic business in the way of reducing grades, improving curves, widening cuts, proper ballasting, equipment, and other expenses, it is difficult to estimate. Probably $2,000,000 would be sufficient to begin a good interoceanic traffic, so that the total estimated cost after September for the harbors and railroad, exclusive of interest during construction, would be about $8,000,000 in round numbers.

The commercial features give rise to questions that are of great moment and far-reaching. For fifteen years the writer has been chiefly interested, next to his engineering work, in the study of the relation of the American isthmus to interoceanic commerce. His investigation has been based upon the government statistics of commerce of the

United States, Great Britain, and other countries, reports of maritime and other exchanges, and the United States consular reports from every quarter, in order to learn what are the products and the imports of each country, and by which routes these are transported. Special study has been given to the development of the commerce of the Suez canal, which has revolutionized the commerce of the globe. All of this has been done in order to arrive at an estimate of the commerce which would fall to the Tehuantepec route when opened.

A special investigation has been made at my request by an acknowledged commercial expert—Mr. Thomas J. Vivian, in charge of transportation statistics of the United States census—who undertook the task of answering, in the shape of a report, nineteen far-reaching questions. The method and the scope of this inquiry and the valuable facts gathered, alone would make a magazine article of great interest. The inquiry embraced the whole world. Commercial movements are in such delicate equilibrium that a disturbance of any kind, an improvement of a route or the opening of a new one, may affect the entire commerce and, with it, the industries of the world. Take the tea trade, for which the Suez canal and the transcontinental lines of the United States are contending. In 1884 49,964,482 pounds of tea reached the Atlantic coast of the United States from China via the Indian ocean, the Suez canal, the Mediterranean, and the Atlantic, while 18,256,764 pounds came across the Pacific, via the transcontinental lines to the country east of the Missouri river. But the San Francisco route is gaining. In 1890 the amount of tea received via Suez had decreased to 43,000,000 pounds, although the total amount handled had increased enormously. At the same time the amount handled by rail had increased to 39,000,000 pounds. It is necessary, therefore, to study the increase, as well as the general movements on the various routes of the entire traffic of the world.

The aggregate commerce of the five principal maritime nations—the United States, Great Britain, Germany, France, and Spain—increased 20 per cent. in the last decade, the annual increase averaging 2 per cent. Probably this rate would be diminished by including the returns from all other nations. It is safe to estimate the annual increase of the commerce of the whole world during the present decade at $1\frac{1}{10}$ per cent., at least, and this figure is used in the estimates which follow. From the sources mentioned tables have been compiled showing the number and registered tonnage of vessels engaged in trade between the ports of twelve countries and the ports of twenty distinct countries on the Pacific and Indian oceans in 1890. Other tables show the commerce on still other routes. Analyses have been made of the amount of freight constituting the transcontinental traffic between the Pacific and points east of the Missouri river, with details of the freight carried from seaboard to seaboard ; even the passenger traffic has been carefully investigated, that transported on certain routes in 1891 being compared with estimates of the percentage and number that would travel in 1896 via the Tehuantepec route, between Australia, Honolulu, China, and Japan to Europe, Pacific, Mexican and Central American ports to Europe, San Francisco to New York via Panama and vice versa, the westward movements, and other, though perhaps less important, travel between Cuba and China via New Orleans ; passengers via the Suez canal and local passengers from all points on the western coast of Central and South America to points east of the isthmus on the Gulf and Atlantic. The time required for freight by various routes and the estimated time via Tehuantepec has been carefully investigated.

As an illustration of the importance of this examination take the following summary as between the representative terminii of New York and San Francisco, in which is given the actual time consumed in days and the distance in statute miles, equating the ocean and rail distance by multiplying the latter by 3 ; although if the equation is made on the basis of the real comparative cost 5 rather than 3 should be used.

ROUTES.	Number of Days.	Miles.
Around Cape Horn (by sail)	140	15,420
Via Straits Magellan (steam)	60	13,090
Via Transcontinental lines (fast freight)	25	10,203
Southern Pacific to New Orleans (rail). New Orleans to New York (steamship, fast freight)	14	9,386
Via Tehuantepec	20	4,280

One of the most important reasons for opening the Tehuantepec route will be seen by comparing the time and distance of the all-rail routes with the time and distance of the half-rail and half-ocean routes by way of New Orleans. In these simple figures lie the main reasons why the Southern Pacific and Morgan line route via New Orleans has been able to obtain from 75 to 90 per cent. of our entire transcontinental traffic. Now, if the fact that this route is one-half water has given it such an immense advantage over the all-rail lines, may we not expect that, by carrying this principle further and uniting the two coasts by a practically all-water route on the shortest possible line, we may obtain some of the immense traffic between the Atlantic and Pacific coasts and interior of the United States? May we not further expect from the new and extraordinary facilities given to this country and particularly to the ports of the Gulf of Mexico we may develop an entirely new coastwise traffic between the southern and eastern coasts of the United States and Mexico and the Pacific?

Freight rates by all the various routes and of different classes of freight have been studied for the purpose of determining a reasonable charge for transportation via Tehuantepec. The highest and lowest freight-rates in 1891 on the eastern and western routes of the world for representative cargoes have been followed in great detail for the purpose of forming a reliable judgment. The varied questions of the present increase of traffic on all the main routes between the various countries and for various products have been investigated and these results applied to the proposed route at Tehuantepec. The estimate of the commerce that will be handled by the National Railroad of Tehuantepec has been based upon (1) the annual increase of the world's commerce, (2) the traffic of the season of 1890-91, and (3) the time fixed for opening up the route (1896). The traffic figures are based on freight tonnage, the rates being on the basis of the weight of commodities and not the registered tonnage of vessels. Instead of quoting a meridian of longitude as the boundary of the "attractive influence" of the Tehuantepec route, the actual reports of shippers and recognized facts, and the trend of commerce, have been taken to show the extent of this influence. It has been properly considered in the estimate that the saving in distance and time by the Tehuantepec route means that by a shorter route a larger number of voyages per annum can be made and consequently greater return to the vessel-owners on their investments and, in addition to this saving, an increase of annual earning capacity of vessels. By the use of the shorter route there would be the saving in the wear and tear of craft by avoiding the stormy routes by Cape of Good Hope and Cape Horn, also smaller cost of insurance and a general diminution of running expenses. It has also been taken into consideration that sailing-vessels could use this route, while it is impracticable for them to use the Suez canal on account of the impossibility of navigating the Red sea, or to use the Panama route on account of unfavorable nautical conditions in both oceans.

The writer contends that the great advantages—geographical, physical, nautical and commercial—of the Tehuantepec route over Cape of Good Hope, Suez canal, Cape Horn, Straits of Magellan, Panama, Nicaragua and the transcontinental lines would enable it to divert to itself and create a combined aggregate tonnage of great magnitude, and that this route can successfully compete with any of those above mentioned, including Nicaragua, which is considered (erroneously in the opinion of the writer) to possess great special advantages. But the writer also knows that the Tehuantepec route must, in order to compete successfully, be fully equipped in extensive terminal and wharf facilities and be operated on the lowest possible grades permissible, with the easiest curvature, with a sufficient equipment of rolling-stock and in close connection with its own steamship line on the Pacific and the Atlantic, with harbors on both sides accessible to the largest ocean vessels under all conditions of weather.

On the above basis a summary of the detailed estimate shows that there may be reasonably expected in 1896 a total through traffic of 5,288,037 tons and that the gross receipts, with the addition of the passenger business and the local traffic on the isthmus from the adjacent and already rapidly-developing country, would amount to over $10,000,000 (gold).

The importance to the United States and to all other maritime nations to provide an interoceanic route, the approaches to which are favorable for sailing vessels, cannot be overestimated. Mr. Romero has given a brief comparison of nautical conditions at various points on the American isthmus which shows the impracticability of sailing vessels using the more southern routes on account of persistent calms and unfavorable winds in both oceans, and the entire practicability at Tehuantepec, on account of favorable winds. The world's tonnage that will be affected by an interoceanic route is larger in sail than in steam. In the fiscal year 1892–93 the fleet employed in trade between European and United States Atlantic ports and between Australasia and the Pacific coast was made up as follows:

	Steam.	Sail.
Register tonnage	2,535,202	3,958,891
Equal to cargo tonnage	3,250,000	6,400,000

In conclusion it should be stated that, by the wisdom and far-seeing policy and the persistent efforts of the president of the Mexican republic, not only the railroad, but the harbors, terminal facilities, and sufficient equipment, and all that is above outlined will be provided within the next three years. The opening of this interoceanic route for the benefit not only of Mexico but of the world is one of President Diaz's cherished objects. The question now is into whose hands will this important route fall for operation and control. Shall it pass to Europeans or to citizens of the United States? The country the citizens of which shall operate it will have for the next century a commercial advantage that cannot be overestimated. By whomsoever operated, this route is certain to effect a revolution more far-reaching and more important to the commerce and industry of the world than that which followed the construction of the Suez canal.

DOMESTIC ELECTRIC LIGHTING PLANTS.

By Nelson W. Perry, E. M.

SOME one has said that civilization is a device of the devil for increasing our wants instead of satisfying them. Certain it is that the luxuries of yesterday are the necessities of to-day, and nowhere has this been made more manifest than in the conveniences that have been provided by the advances in electrical science during the past two decades. But if the advance in science has done naught but to stimulate our desires, it has fallen far short of its province ; nor will our experience bear out such a statement. There is an old saying that there is an innate tendency in the human makeup to revert back to the savage state ; but who that has once availed himself of the facilities of the telegraph and the telephone, by which distances are annihilated would now magnify those distances by the methods of long ago? Who that has enjoyed the humane and rapid methods of urban electric transit would willingly return to the plodding car horse or mule? Who that has accustomed himself to the brilliant and healthful illumination by the electric arc and incandescent filament would exchange them for the tallow dip or the rushlight of our fathers? All these things have now become a part—a necessary part of our metropolitan civilization. And yet even more. The telegraph and the telephone have long since overstepped all mural bounds and the electric railroad is fast invading the precincts of the turnpike, the county road, and even the territory of the steam locomotive. The electric light, however, has thus far, in this country, remained only for those living in communities of sufficient size to make the distribution of electric current in large quantities profitable to companies organized for the purpose. To many of these, too, the electric current, on account of its greater cost than gas, still remains a luxury ; but with those of means, especially the business man, it has already taken its place among the necessities of the times to such an extent that no business building is now considered modern in its equipment that is not supplied throughout with the electric light.

Whatever may be said of the conservatism of England and of Germany that has prevented them from ranking with the United States in the adoption of modern innovations, those two countries have far outstripped us in the solution of the problem of cheap domestic electric lighting, and we must learn of them, as at Gamaliel's feet, the lessons they have already learned and have proved so well.

It is from these two countries that we have learned what at first appears so anomalous, viz.: that more light can be obtained by using gas in a gas engine driving a dynamo than can be obtained by burning that same gas direct in the best gas burner. There are few who will accept this statement without corroborative proof, and it is the purpose of this article to supply that proof by figures taken from actual practice within the experience of the author. It may be well, however, to introduce such demonstration by indicating how, on theoretical grounds, such a showing is well within the bounds of possibility, and then to follow it up by showing how well the actual results conform to those we are led to expect from mere theory.

Prof. Tyndall gives the average luminous radiations from a gas flame as only $\frac{317}{1000}$ per cent. of the total radiations. The production of light by burning gas is therefore one of the most uneconomical transformations of energy that man is accustomed to employ.

The incandescent electric lamp, however, has a much greater light efficiency than the gas flame. A 3.5 watt lamp, viz., one consuming 3.5 watts per candle power has a light efficiency of 6 per cent. or 18.8 times that of the gas flame. The gas engine not infrequently has a thermal efficiency of 20 per cent., and a mechanical efficiency of 85 per cent.; the dynamo efficiency may be taken at 95 per cent. and the light efficiency of the incandescent lamp being as above equal to 6 per cent. we will have a final efficiency after these several transformations of $20\% \times 85\% \times 95\% \times 6\% = \frac{969}{1000}$ of 1%.

But in practice there are some other losses than those taken account of above. The dynamo is usually belted to the engine, involving a loss approximating 10 per cent. There is also a loss in transmission of the current from the dynamo to the lamps. For present purposes this may be placed at 5 per cent. Assuming an efficiency of our dynamo of 95 per cent. we may call the combined efficiency of dynamo and belt and electrical transmission 80 per cent. The efficiency of the various transformations from the gas to the electric light becomes therefore $20\% \times 80\% \times 85\% \times 6\% = \frac{816}{1000}$ per cent. as against $\frac{317}{1000}$ per cent. for gas direct or a ratio of 2.57 to 1. This is to say that for every candle power produced in consuming gas in a burner direct there can be produced through the intermediary of the gas engine, dynamo and incandescent lamp 2.57 candle power from the same gas.

As indicating the extent to which gas engines are used abroad. Mr. F. H. Mason, the United States consul to Germany, in a report to our government last spring stated that at that time the number of gas motors in use in Germany in all the smaller forms of manufacture where the motive power required did not exceed 75 to 150 horse-power, amounted to 18,000, aggregating 60,000 horse-power; and estimates that through the cheapening of gas the rapid extension of electric lighting and other applications of electricity the use of gas engines has been very largely increased since then. In evidence of this, he states that the two principal makers of gas engines in Germany have alone made and delivered during the past two years 1950 such motors, and estimates that the number in actual service in Germany cannot now be far short of 24,000 to 25,000.

An English estimate places the total number of gas engines in use in England at about 40,000, of which, according to Mr. Dowson, about 12½ per cent. are employed for electric generation. There are no figures at hand for the number of gas engines in use in this country, but while it is undoubtedly much less than in either Germany or England, it is still quite large, though the percentage used to drive electrical machinery is as yet quite insignificant. The extent to which they are used both here and abroad is sufficient however to show that they have passed the experimental stages, and have already become important factors in all questions in which prime movers are concerned.

Thus far we have arrived at the economy of the gas engine from theoretical deductions. That conclusions thus reached will not be satisfactory I am well aware, and my paper would be incomplete were not well authenticated data brought to substantiate these claims.

Leaving out of consideration data of actual working abroad, for the reason that some of the conditions there and here are so different as to render them of little value for purposes of comparison, we come to the somewhat limited practice in this country. In the first place, the makers of gas engines here will guarantee the production of an actual horse-power for 1 hour by the consumption of from 17 to 20 cubic feet of gas, or a pint of gasoline. This is somewhat better than is usually guaranteed by European makers, but such figures must be considered always as mere approximations, and as somewhat indefinite unless the quality of the gas or gasoline be also specified. In general whatever is said here in regard to gas engines applies equally to gasoline engines, with the reservation that gasoline is somewhat more economical fuel than gas.

As showing the reasonableness of the figures claimed by the gas engine manufacturers, and also of those used in this paper in the calculations presented, I append the results of a very careful series of tests made by Messrs. W. F. Hunt and W. J. Andrews, of Cornell University.

Engine No. 1 was a 12 horse-power nominal, and engine No. 2 a 6 horse-power nominal with dimensions as follows:

	No. 1.	No. 2.
Diameter of piston	6.75″	5.75″
Length of stroke	1.2916 ft.	1.041 ft.
Clearance, % vol.	34.95	25.63

No. of Engine.	No. of Test.	R. P. M.	Explosions per Min.	I. H. P.	D. H. P.	Cu. ft. Gas. per I. H. P.	Cu. ft. Gas. per D. H. P.	B. T. U. per I. H. P.	Mechanical Effic.	Thermal Efficiency.	Cost per D. H. P.	Cost pr. E. H. P., 15% Loss	Cost per Lamp-hour @ 12 Lamps per H. P.
1	1	245	73	9.	7.03	18.125	23.2	12358	.781	.205	3.48	4.09	0.34
1	2	246	120	15.35	12.9	17.825	20.43	12150	.842	.209	3.06	3.6	0.3
2	3	305	143	9.38	8.38	19.78	22.14	13460	.893	.189	3.32	3.9	0.33
2	4	265	123	8.50	7.66	18.4	20.42	12460	.901	.204	3.063	3.6	0.3
2	5	312	153	10.12	9.08	19.235	21.416	13040	.897	.1951	3.22	3.79	0.32
2	6	303	15.2	1.09	0	18.36	......	12350	....	.206	...	...	...
2	7	307	78.2	5.31	4.28	19.89	24.68	13410	.807	.28925	3.70	4.35	0.36
2	8	304	86.8	5.98	4.83	18.525	22.95	12555	.808	.2025	3.44	4.04	0.34

The last three columns I have calculated myself from the data given by Hunt and Andrews assuming the cost of gas used to be $1.50 per 1000 cubic feet.

It will be seen from this table that the cost per lamp-hour (one 16 candle-power lamp for one hour) reaches a minimum of $\frac{3}{10}$ of a cent in both engines when fully loaded, and $\frac{34}{100}$ and $\frac{36}{100}$ of a cent respectively for numbers 1 and 2 when running under light load. On the other hand, on the assumption that it requires 5 cubic feet of gas to produce the same amount of light for the same time, the cost would be $\frac{75}{100}$ of a cent.

It also becomes apparent that if the gas engine can be relied upon to do its work properly with the attendance that can be given it by ordinary domestic help, it furnishes a happy solution of the question of cheap electric lighting not only for city residences but also for suburban and country homes. To settle this latter question, the writer has corresponded with a large number of owners of private lighting plants operated by gas and gasoline engines, as to their experience with them. Nearly all of the replies received were of a favorable nature as far as they went, but there are few who have ever kept a sufficiently close tally upon the operation of their plants to enable them to give specific information in regard to the economies attained.

Their letters received are, however, instructive, and of sufficient interest to warrant their reproduction in part here.

Messrs. Wm. S. Sons & Co., Dry Goods Commission Merchants, Philadelphia, Pa., write that they have a 6 horse-power gas engine operating a 2½ k. w. (3⅓ horse-power) dynamo, which they introduced "simply for comfort and convenience" and that the "cost of running and repairs has not been considered by them." However, they give the following data in response to my inquiries. The daily use of the plant varies from 12 hours to nothing. The average number of lamps at one time is given as 25, and the average use per day as about 4 hours. Their gas bills for engine show a consumption of 150,400 cubic feet of gas in 299 working days or an average of 503 cubic feet daily. Gas costs $1 per 1000 cubic feet, making the cost 50 3/10 cents per day, or a little over ¼ cent per lamp per hour.

The plant has been in operation nearly four years and originally cost complete $1400. The lamps are steady and entirely satisfactory. Engine attended to by porter in store. Cost for repairs stated to be not over $20 per annum, including lamp renewals.

Messrs. W. Bros., Manufacturers of Pianos, New York city, reply that they have a 15 horse-power gas engine, operating a dynamo of from 12 to 13 horse-power. The maximum number of lamps wired is 150 ; the maximum number ever used at one time is 140, and these vary from 2 to 6 hours per day. They write that "We used gas for lighting before we had the electric plant. The electric plant is a great deal the cheaper." This plant has been in operation nearly three years, and they state that it has cost them scarcely anything for repairs. The lights are very steady when the engine is working nearly up to full load, but show some unsteadiness when the load is light. The engine cost about $1700 and the electric plant, put in complete, cost $1650.

Messrs. B. Bros., Bronze Statuary and Founders, Philadelphia, write that in 1891 they put in a 9 horse-power gas engine at a cost of $900 and a 90-light dynamo at a cost of $380, including all wiring, 4 arc and 25 incandescent lamps, "We have at the present time," they say, "4 arc lamps and about 25 incandescent lamps in when lit up, and generally use them from 4.30 to 6.30 P. M.; and for the last three weeks have been using 2 arc and 15 incandescent lamps from 6 to 9 P. M. After starting up we do not have to give engine or dynamo any attention whatever until stopping time. The engine uses about ¼ of a gallon—a little under—of gasoline of 75° per horse-power per hour, at 9 cents per gallon, which makes pretty cheap lighting. The lights are slightly unsteady at each discharge of the engine, which can be overcome, however, by using a fly-wheel on the engine. We do not find this unsteadiness in the least annoying, as we can read and write very well with it. We also do our very fine molding with it, which was very trying under the old way of using gas light, and our men would not go back to gas. . . The engine after it is oiled and started up does not require any attention. Neither the engine or dynamo have cost us anything for repairs from the time of placing them in our works. . . We think that it is the best and cheapest lighting that can be had. The only objection is the first great cost for installing the plant in a house or shop. Anybody, once shown how to start the engine, can run it."

Mr. Jos. I. K., Importer and Commission Merchant, Philadelphia, is employing a gas engine to run his elevator and about 25 incandescent lamps. He writes that his plant has been in operation for nearly six years. His light, he says, is cheaper and better than gas, and the repairs to the entire plant have averaged less than $20 per annum. In conclusion, he says "my experience in the matter in connection with which I forward the above replies has been perfectly satisfactory in every way."

The above are fair samples of many answers received; but, as before stated, they are more general than specific. In order that I might have more accurate data at hand, I have personally examined and tested a number of lighting plants, one of which I will describe briefly as typical of one of the two systems of lighting now in vogue with gas engines as prime motors. This is the private plant at the residence of Mr. G. Morosini, at Riverdale, on the Hudson.

This plant is noteworthy as being probably the largest and most complete private lighting plant of the kind in the country. It consists of two White & Middleton gasoline engines belted each to a 10 horsepower Perret generator. These latter are connected with a switchboard which is also double, so that either dynamo may be separately connected with the house circuits or with the storage battery; or they may be connected together in parallel with either the house circuits or the battery. The storage battery consists of two series of Consolidated Electric Storage Battery cells, each of 60 cells, which when connected in parallel, have a normal discharge rate of 70 amperes. This plant is installed in a small brick building some distance from the house. Except on special occasions when the full capacity of the plant is required, the lighting is done entirely from the storage battery; but on these special occasions both the battery and the dynamo are put into service. In charging the battery but one dynamo is used, and this is run so as to give a current of 73 amperes at from 125 to 150 volts. The charging of the battery occupies two or three hours per day, during which time only is the machinery usually in operation.

When the dynamo is charging the batteries at the rate of 63 amperes and 145 volts the engine consumes 4 gallons of gasoline per hour. Estimating the cost of gasoline when bought by the barrel at 8½ cents per gallon makes the engine and dynamo cost for this service equal 36 cents per hour. Let us assume for the sake of a margin, however, that the oil costs 10 cents per gallon, the cost per hour for fuel in charging the storage battery will be 40 cents. 63 amperes at 145 volts=9135 watts=12.2 horse power, cost 40 cents=3.28 cents per horse power per hour. If this current were delivered directly to the lamps through the mains, allowing 10 per cent. loss in transmission there would be an effective E. M. F. at the lamp terminals of 145—14.5=130.5 volts. If the lamps be 110 volt lamps and their resistance 220 ohms, they will each take $\frac{131}{220}$=.59 amperes of current, say 0.6 amperes. If each lamp takes 0.6 amperes and there are 59 amperes available, the 4 gallons of oil will supply $\frac{56}{0.6}$=93 lamps at a cost of 40 cents, or at the rate of $\frac{40}{93}$=0.43 cents per lamp per hour. This corresponds very closely with the figures arrived at from theoretical considerations. But the current from this plant is not usually used in the lamps direct, but for charging the storage battery. By this latter recourse much better service is obtained in that the current is available at all times independent of the engine, and the lights are absolutely steady. These greater conveniences are obtained, however, at a much greater cost both in original outlay and in running expenses. As to original outlay for plant about 100 per cent. must be added for storage battery and in operating expenses about 20 per cent. Allowing for the latter, the figures for operating cost must be increased from 0.43 cent per lamp hour to about 10.54 cents. Mr. Morosini also employs an electrician to attend to his plant who devotes about 3 hours per day to this service, the cost of which must also be charged against the lamps. This additional charge, as well as those for interest on the investment, depreciation, etc., will be practically constant whether many or few lamps are burning for a greater or less length of time. It will of course be much less with a large number of lamps than with a few and less in winter because of the greater number of lamp hours than in summer. As a matter of fact Mr. Morosini's residence is wired for 400 lamps and the consumption of current averages in summer 200 ampere hours and in winter about 400 ampere hours per night—respectively equivalent to about 400 and 800 lamp hours, which means an additional charge on account of attendance of about ½ and ¼ cents per lamp per hour. This will bring the cost of lights up to 1 cent an hour in summer and ¾ cents per hour in winter. Comparing this with the cost of electric lighting as furnished from the central station we find it is about the same in summer and a little cheaper in winter, the charges for central station service being universally 1 cent per lamp hour. With gas at $1.50 per 1000 cubic feet, assuming 5 cubic feet of gas to give an equivalent to 16 candles, the cost would be ¾ cent per lamp hour or the same as the electric light costs Mr. Morisini in winter time under the above assumptions. On the other hand, another gas plant, using gas without the storage battery, supplied 56 lamps (which was about half load for the engine) with a consumption of 160 cubic feet of gas or at a cost of $\frac{43}{100}$ cent per lamp per hour. These lamps, operated at about 115 volts pressure, considerably exceeded their rated power of 16 candles each.

The noise of the gas engine is its greatest objection for domestic uses, but this has been greatly reduced by connecting the exhaust pipe with underground or otherwise muffled chambers.

If storage batteries be used, the generating plant may be materially reduced in size. Undoubtedly one third of the power required for direct lighting would be sufficient under these circumstances on account of the short hours of service required in private residences. As a further offset to the additional expense of the storage battery the engines may, when working, operate at their maximum load, and therefore under far more economical conditions than usually met with when they supply current direct to the lamps. Prof. Kennedy is responsible for the statement that the consumption of gas per horse power in a gas engine at half load is 40 per cent. more than that required at full load. Assuming this to be true the loss of 20 per cent. which we have allowed in the storage battery is considerably more than counterbalanced by the increased efficiency of the engine.

The storage battery more than doubles the cost of installation except in very small plants where the increase is slightly less than 100 per cent. For this reason many will prefer the plant without the storage battery. They will, however, have to put up with the inconvenience of running the engine as long as the light is required at night and doing without light from this time until the engine is started up again. In many cases this will not prove an inconvenience.

One of the greatest drawbacks to the more general introduction of lighting plants such as here advocated has been the absence of any one who would guarantee the performance of the plant as a whole. Heretofore one company has put in the engine, another the dynamo and a third the storage battery, etc. The investor has therefore been compelled to assume the risk and responsibility which has in some cases proved irksome. The average investor, too, seldom has the time to investigate the merits of the various parts that go to make up the plant and still less often is he qualified to discriminate between what is bad and what is really good. What is required is a firm or company that will assume all these obligations, that will contract to erect a plant complete for a certain price on a guarantee of performance without the fulfillment of which they will hold the investor safe, and without expense for the experiment. There would seem to be an immense field for the proper parties in this direction. The only astonishing thing about it being that it has remained so long unoccupied.

EDITORIAL

Municipal Engineering and Politics.

ONE of the most notable specimens of engineering construction ever carried out in the United States by the funds of a municipality, is that described and illustrated in the interesting article contributed to the present number of this Magazine by Mr. Frank E. Snyder, C. E. The great dam at Austin is exceptional in American engineering on three distinct lines. It is perhaps the first attempt of a municipality to engage in the business of power supply to shops and factories, and, as such, it is extremely interesting as an initial experiment in a new line of municipal ownership. It is interesting also as an engineering work *per se*. It is further of interest as a specimen of municipal engineering construction which has escaped serious defects usually forced upon municipal contract work through concessions to political rings or to incompetent officials whose offices are due to political influence, and who, while they may be adepts in politics know very little or nothing of engineering problems.

Considered as an experiment in municipal ownership, there will be, of course, two entirely opposite views as to the wisdom of such undertakings on the part of city governments. By some it will be deemed directly in the line of human progress—a step toward the parental government which many are urging as a great scheme for ameliorating special ills now burdening society. On the other hand, there is a school of able thinkers who believe these ills to be temporary—the nominal result of a transition stage, and that they will disappear when the framework of society has adjusted itself to new conditions; just as the walls of a building cease to crack after the foundations have settled to a rigid basis. These economists believe that parental government would simply entail greater evils than those now existing which all would gladly join in removing could the unmistakable way for their removal be clearly pointed out.

Progress in municipal engineering has been obstructed in two ways. The first is, that engineers who have much to do with city contracts are, as a rule, compelled also to be political wire-pullers; or, if not that, to get a pull with the wire-pullers by dividing profits with the latter in order to obtain the contracts. Few men have ever succeeded in combining two callings and taking front rank in either. It is hard to conceive of anything more opposed to the thorough, consecutive, calm consideration of engineering problems necessary to their successful solution, than a political scramble, or anything more obstructive to good engineering work than the concessions to political hucksters that contractors are obliged to make in the execution of important city work, such as the enforced employment of incompetent assistants, or the purchase of inferior materials from men who are in the ring and who will prove obstructive unless their demands are met, with all the other "ways that are dark" of the modern city politician.

The fact is, that too many things needed for the supply of the necessities of urban life are now controlled by gangs of political robbers; yet they would be rejoiced to get more. Municipal ownership of gas works, of street railways, of rapid transit lines, of electric lighting plants, simply means more opportunities, more places for ward heelers; in a word, more robbery from the public purse. There cannot be too much municipal ownership to suit rings. The fatness of street cleaning contracts, of jobs in paving streets, of care of public buildings and property, of docks and parks, of police and fire departments have not and cannot satisfy a greed which is insatiable; and if the control of fuel and food supply, and all the other necessaries of life were offered to this political Moloch of modern municipal rule, its cavernous mouth would open like an alligator's to gulp it in. In the light which has lately been shed upon the true inwardness of municipal rule, it is difficult to conceive how any man, educated, intelligent and sane, can, with a good conscience advocate any extension of municipal ownership. The history of public works in American cities is blotted all along the line with fraud, blackmail and other forms of extortion. It is only a short time since a large contract for constructing a street railway was abandoned in the city of New York by a firm in Philadelphia, after much work had been done upon it. The reason assigned by the Philadelphia firm was that the New York city officials so obstructed the progress of the work (one of their favorite contractors having been underbid in the letting of the contract) that there was no possibility of finishing the work in the time specified; and the Philadelphia firm preferred to lose the large sum they had already expended, rather than make any further attempts to struggle against the obstacles constantly so interposed, and thus to risk further losses. Whether this statement could have been substantiated by evidence or not, no one who knows how things have been managed in New York for many years would consider it at all improbable.

The extension of municipal ownership will increase the burdens of any city that indulges in such folly. Affairs may run smoothly enough for a time, but when the harvest gets ripe the rings will surely reap it.

Architectural Criticism.

ARCHITECTURAL criticism must be good or bad. Some very bad examples have lately been referred to in these pages, and further examples, as must necessarily come to light from time to time, will be commented upon in due course. That most of what passes as architectural criticism is bad doubtless no architect will hesitate to affirm. And in this the architects are generally right. Mere wordiness is no proof of critical ability, and it would seem to be the first requisite of every writer on architecture that he first equip himself with at least an elementary knowledge of what architecture is and how it is practiced, and learn the position of architects towards their art. Just criticism is almost impossible unless a writer will limit himself to certain phases of the art with which he can make himself familiar. The manifold conditions under which architecture is now practised throughout the civilized world render it almost impossible to judge buildings by referring them to some ideal standard that can never be reached in actual practice. The critic is not the only one who suffers from this, for it is the most vexatious thing the architect himself has to consider. Unless, therefore, the critic can bring himself to a modern atmosphere and learn to know and to realize the limiting conditions under which all architects are forced to work, it would be better that he never opened his mouth at all, be his language ever so refined. The question of language has really a great deal to do with it, since very many people imagine that skill in setting forth signs of ideas—that is to say, words—is the foundation on which the critic rests. This is generally the fact, but it is utterly wrong. It's much easier to take buildings to pieces than to design and construct them, and it is this which gives the critic his hold upon the popular fancy and makes his essays attractive to the average magazine editor. Of the reams of architectural articles that have been published in the last five years there has not been one, if our memory serves us aright, that deals with the actual conditions of modern architecture. Professor A. D. F. Hamlin did, it is true, write most lucidly and sympathetically on this very point in the *Architectural Record* some years ago, but his articles reached a professional audience rather than a popular one. But with this exception we have had nothing but comments, ravings, praises, condemnations,—varying according to the temperament of the writer and his sympathy with the subject he is attempting to elucidate. And as it is easy to praise, if one be a faddist, or to condemn, if one be a censurist, most of the architectural writings in the popular press have been of either of these descriptions.

Architectural writers may be severe in treating of architects, but it would be an even wager that architects could excel them if they would take the opportunity to speak aloud the impressions they keep to themselves. Each architect is the best architect in the world. If he is not better than the next fellow he has little excuse for practising his profession. And unless he has a full appreciation of the strong points in his work he cannot expect others to have it. But what architect who has taken part in a competition for a building, unless he is a very young man who goes into it more for the reputation it may bring him, is ever satisfied with the result if he is not successful? The most he will do is to admit that his design would have been as good as the accepted one. And then he will imagine all sorts of impossible reasons why the other should have been taken and he left. What architect ever visited an architectural exhibition who did not know that his designs, which he cannot see anywhere, were infinitely better than 99 per cent. of those hung? So it goes. And if these gentlemen were to take the trouble to write down their deliberate judgment of their brothers in architecture, the poor critic, with all the dictionaries in the world, would make a very slight showing. Wholesale condemnation of the critic is, therefore, as unwise as the latter's wholesale condemnation of architects. Both sin alike in their own way. Each is alive to the mote in the other's eye, while blind to the beam in his own. Yet should the architect, who is so ready to condemn brother architects, find fault with the critic for doing exactly the same thing he does, especially when he does it in a milder manner and with a greater assumption of justice? The architect's ideal of criticism is not sharp words but gentle praises. He knows the evil of indiscriminate praise and does not look for it, but when he has put weeks of thought into a work, done his very best and striven to surpass himself and his contemporaries, he cannot see why a man (or woman) who knows nothing of the mental state he has been in should condemn him off-hand. The position has some reason in it, but it is not wholly reasonable. So much of what passes as architectural criticism is so light and unimportant that the wisest course is to consider the source and disregard it. B. F.

The Hudson River Bridge.

SINCE the report of the board of experts to the War Department was issued some time ago, expressions of opinion on the report have been advanced from almost every engineering authority; and these opinions, while recognizing the spirit of fairness and conservatism of the board in making its estimates and drawing its conclusions, are for the most part in dissent.

As in every similar large project, there are two main questions to be considered—the engineering feasibility and the commercial profit. Further, ideals of safety and efficiency must always be modified by considerations of expediency, so that no structure is quite up to the mark aimed at by the engineer and is necessarily a sort of compromise.

The board holds—and its dictum is supported by the whole consensus of the profession—that either a suspension or a cantilever bridge could be built and would be a safe and serviceable structure, with a clear span of either 2000, 3100 or 3200 feet—the first being the agreed minimum, since although a center pier might be permissible so far as navigability of the river is concerned, it would be almost out of the question on account of the immense depth and unknown cost of caisson work through water, silt and sand. Speaking broadly, there are four possible alternatives, since the prohibition of false work excludes all other systems but the suspension and the cantilever. These are: (1) the 2000-span cantilever, (2) the 2000-span suspension, (3) the 3100 or 3200 cantilever, and (4) a suspension bridge of equivalent span. The board inclines to favor the modified combination system of a suspension bridge with a heavy stiffening truss to meet the requirements of a six-track full-speed railway traffic. Railroad men almost unanimously prefer the cantilever because of its rigidity, as against the light suspension system; but the board's favored design would satisfy them.

As to costs, the board prudently declined to commit itself, making estimates only by way of comparison between different systems, assuming certain bases of duty and cost of material—where these are comparable. Even here the board's figures have been criticised adversely, it being shown that the estimates of 4½ cents per pound for steel work and 8 cents per pound for wire work were both in excess of what responsible constructing companies were ready to bid.

The New York and New Jersey Bridge Company itself favors the shorter distance (2000 feet) cantilever, as better adapted to heavy railway traffic and quicker to be constructed. Comparison is mainly between this and the long-span suspension designs.

The costs, so far as the bridge construction alone is involved, range from somewhere in the twenties to the thirties of millions of dollars, and various minor deviations in the plans bring out a series of estimates hardly worth citing, for, to speak plainly, they are mere guesses for the most part upon unknown data and unprecedented conditions. It is comparatively plain sailing to compute weights, stresses and sections for either form of bridge, and to get bids for construction of the superstructure which will bring the actual cost within definite limits; but as to the caisson work and pier building under adverse conditions so far beyond all previous experience, all figuring is uncertain.

However, these are not the matters we wish to emphasize here. Granting that a "safe and serviceable" bridge can be built across the Hudson at New York—as we all do, and as we all know must be built sometime, unless the tunnel schemes turn out more promising than at present—the great questions for the public are: Will such a bridge pay? Is it wanted so much now that the investment is warranted?

"Well, and what business is it of the public whether the enterprise is financially successful or not?" it might be in turn asked, "provided the bridge company takes its own risk and fulfills its charter requirements?" It does not do to "jump on" private enterprise, however daring; for if such a spirit had always prevailed we should have had no railroads, no steamships, no telegraphs—hardly any of the achievements of modern enterprise. And now that countless millions of capital are ready at hand to back any project that promises good returns, the facilities are vastly enlarged and the engineering possibilities almost boundless, so that the carving of Mount Athos, the ultimate completion of the Panama canal, the French Atlantic-Mediterranean canal, and a host of ancient and modern projects are well within the limits of engineering practicability and financial support. But in this case the public has a decided interest. The company starts with a creditable independence and fair dealing, but it will want to market its shares and bonds. It will come in conflict with other transportation interests. It will inevitably collide with private ownership of real estate. All these are not finally deterrent if the enterprise is shown in advance to promise profit. But who can say?

We honestly believe that the total cost of the proposed Hudson river bridge between New York city and New Jersey at somewhere between 55th to 65th streets, New York, will not be the $22,000,000 of the bottom estimate, but something like $100,000,000, with an indefinite margin that no one can foresee, by the time that the piers are put in, the bridge is built, the terminal property condemned and acquired, and the whole machinery in working order. In the end it will be found that the real estate problem will be the dominant one. Experience in all similar cases —and notably in that of the Brooklyn bridge—shows that the mere engineering and construction costs are only a fraction of the final total. If the New York and New Jersey Bridge Company have fairly computed all these outside but preponderant costs, and are satisfied that their estimated income will cover interest charges let them go ahead—and success be with them!

Mine Titles.

In his very clear review of the history and effects of the United States mining law, printed elsewhere in this issue, Mr. Wynkoop draws attention to the underlying principles which should regulate ownership of mineral-bearing ground. That these principles are generally recognized is sufficiently shown by the almost unanimous tone and tendency of the laws in all countries which have mining laws at all. Putting the matter in somewhat different shape from that worked out in Mr. Wynkoop's able discussion, it may be said that there are three several interests at stake.

First in importance comes that of the commonwealth, which requires that natural resources should be availed of to the fullest economic extent, and that no one should be allowed to monopolize such resources and let them lie stagnant because of inability or unwillingness to develop them, or to hold them dormant for speculative purposes. To this end most countries rich in mineral resources jealously maintain their fee to the mineral ground, whether they are ruled in one way or another, as under monarchies, as republics, or as colonies instituting their own laws. In this respect the United States law is more liberal than that of any other country. The condition required for maintenance of title to unpatented claims is that at least $100 worth of labor must be done yearly on each location, and this has been construed so as to permit concentration of work upon one of a group of claims, to apply to improvements (such as buildings and roads) not strictly mining work, and recently even this very moderate requirement of annual assessment work was suspended for one year by act of congress. But however strict or lax the laws of the different mining countries may be, the same principle of occupation and use is recognized. The liberality of the United States mining law may be ascribed to the intent of its framers to stimulate prospecting and the finding of mineral, as well as to develop and utilize it when found. If, however, the small amount of assessment work is not performed, the claim is open to relocation.

It is regarding the second interest—that of the holder—that the practical difficulty in formulating equitable laws comes in. As a matter of fact and record, there is hardly a mine of any importance held under the United States law that has not been through the courts or is not still subject to litigation. This litigation is not only extremely costly, involving the employment of high-priced lawyers and expert witnesses, but it is tedious and wholly uncertain. A case may take years in settlement, passing from district courts finally up to the U. S. supreme court, with frequent reversals and with the chance (which has sometimes proved a reality) of the supreme court reversing itself. The remedy is plain. If the extra-lateral right—that of the owner of an "apex" to follow his lode (or other form of deposit) down on the dip beyond the vertical projection of his side lines—were withdrawn, and title secured to everything within the vertical planes of surface boundaries, and to that only, there would be no more uncertainty about mining property than ordinary real estate, the issue narrowing down to a mere matter of survey, the actual presence of mineral, and compliance with assessment-work requirements. To give the owner a fair chance underground, if his lode dips at a small angle, the width of claims should be increased and something taken off the length to equalize areas. About 900 × 900 feet is considered a fair-sized surface area; but whatever the size determined upon, it would be possible to fix upon some form of "square location" (which does not necessarily mean square literally, but merely a shorter and wider area with finite boundaries) that would be generally satisfactory. As Mr. Wynkoop points out, the intention of the capable commission that drafted the law of 1872—the existing one—was to restrict the owner to working within all of his boundaries, which provision was amended in favor of extra-lateral rights by the wishes and arguments of those who at the time had in mind only the typical "true fissure" veins in granite and eruptive rocks, and had no idea of the perplexing irregularities of deposits in limestone and the host of deposits which almost elude classification.

The third interest is bound up with that of the commonwealth. It is the inherent right of men to occupy that which is of no service to others. Here self-interest works in behalf of the public weal. But it is possible to carry the principle too far. It is quite true, as Mr. Wynkoop's miner-orator declares, that "air, water, the earth and all its mines belong to humanity and no man has a right to monopolize any more of any one of these than he can use"; but when it is attempted to embody the doctrine in a definite code we are treading on dangerous ground. He who has expended his thought, his time and his money in developing and making useful mineral ground that without such effort would have lain useless, has created a value and should be protected in its holding so long as he conforms with the higher principle of the public good. A rigid enforcement of the assessment work provision secures the latter purpose. Just now the one and all-important demand is for security of title. To effect this our anomalous system of land patents was devised. But even such patents do not absolutely protect, any more than patents to inventions, or copyrights, or trade-marks; while they have the deterrent effect upon the mining industry of permitting mineral territory to remain unworked. The many amendments and substitutions to the United States mining law heretofore proposed are by no means satisfactory. They tend to further complicate what is already unnecessarily intricate. The guiding principle of the existing law is just, both to the nation and to the individual. It is in the forced adaptation of fixed law to widely varying geological conditions that the trouble comes in. Once simplify it by excluding the need of uncertain expert testimony and the interpretation of varying natural conditions, and retain or increase the requirement for utilization, and the tenure of mining territory will become as safe and as equitable as that of common real estate. No new law can be retroactive and invade existing rights, but there is still time to provide for the future, and there is an urgency that this should be done, to the end that mines worth working shall be worked and those not profitable or prospectively profitable shall be abandoned, and that the present constant drain for legal expenses may be done away with.

Electric Competition with Steam Railroads.

No small amount of newspaper comment has been occasioned by the statement of the president of the New York, New Haven and Hartford railroad company, in his report to the stockholders of that corporation at the annual meeting last month, to the effect that the increasing application of electricity as a motive power on highways, is likely to appreciably diminish the earnings of steam railroads from local travel, and that the latter will be compelled to lessen their local service in proportion to their diminished business. It is further suggested by him that there is an element of injustice in the demands of the public upon the steam railroads for expensive stations, prompt and frequent train service, and protection of crossings by gates and flagmen, in competition with the free rights-of-way and cheaper construction of electric railroads. The local newspapers have within the past month chronicled a number of instances, mostly in New England, in which the local steam-railway service has been materially curtailed in consequence of electric competition. With the revival of general business, nothing is more certain than that the number of these competitive electric enterprises will be largely increased. What will be the final outcome? Naturally, the citizens of the municipalities accommodated by electric lines have encouraged their construction in every possible way, by subscriptions to their stock and bonds, and by granting them almost unrestricted privileges in respect to the occupation of the public highways. The result has been to stimulate the construction of competitive electric lines in many places where, as time will demonstrate, they cannot be operated at a profit. In some instances where the local conditions are favorable, they may prove profitable and successful. In either case, nothing seems more certain than that for their own protection, the steam railroad corporations will ultimately be compelled to secure control, directly or indirectly, of all electric street-railways which seriously compete with them. In view of this possibility, not to say certainty, it would seem to be the part of wisdom for the municipal authorities of towns to exercise a good deal of discretion in granting exclusive and perpetual franchises for the occupation of their streets and roads to eleetric railway companies. If they assume that the steam railroad companies will quietly submit to the diversion of an important and profitable portion of their traffic, without resorting to every possible means to protect themselves, they may ultimately find that they have made a serious mistake.

Electro-Technical Literature.

It is with much gratification that we observe a marked improvement in the character of the technical literature relating to electricity and its industrial applications, published or announced for publication during the past year. Few persons who have not had occasion to become conversant with the subject have any adequate conception of the utter worthlessness, either to the professional worker or to the serious student, of nine-tenths of the so-called electrical books which have flowed in an ever-increasing stream from the presses of the publishers during the past fifteen years. Up to within a comparatively short time, it would have been a matter of little difficulty to have compiled a list of about a dozen treatises comprising about everything in print of real permanent value, outside the files of the leading technical periodicals. Perhaps the most striking characteristic manifest in the work of the more modern electrical authors is the tendency to specialization; involving the separate treatment of each subdivision of the general subject by an acknowledged authority. Some of the more recent works of this class, such as Silvanus Thompson's Electromagnet, Crocker & Wheeler's Dynamos and Motors, Crosby & Bell's Electric Railways, Noll's Wiring, and others which might be mentioned, are models in their way, and are doing noble work in raising the standard of intelligence and good service among among young men engaged in the various electrical industries. Voluminous and heterogeneous compilations, of the Du-Moncel and Prescott type, though in their day not without their uses, are now but relics of an age that has passed away.

Sanitary Plumbing.

The papers read before the recent Sanitary Congress in Liverpool, and the discussions these elicited again bring the dangers to health and life through the spread of infection by sewers to public attention. There can remain no doubt in the minds of intelligent and well-informed men that to avoid such dangers the whole system of house drainage should be constructed from beginning to end in accordance with the most advanced principles and methods of sanitary plumbing and sewer construction. People with small means hesitate when sanitary plumbing is named, because, in the popular mind, this term is thought to mean also expensive plumbing. The newspapers describe the gorgeous appliances and fittings going into some millionaire's houses in glowing language, and speak of this sort of thing as sanitary plumbing; and the man of small means gets the idea that sanitation is an accompaniment of splendid living only possible to the wealthy. This is a great mistake. Sanitary plumbing means nothing more than plain plumbing done on sound principles, the practical application of which need cost very little more, either in material or labor, than a defective job. It will cost the plumber who does it something more than the common, inferior sort of plumbing. It will demand more brains, knowledge, and skill. The leading plumbers in this country have acquired the leading knowledge and skill, and are prepared to do their work as perfectly as the present state of the art will permit; and if fancy work be not demanded, will do it in sanitary respects as well for the man of limited means as it can be done for a millionaire.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of these articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B... Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J.Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G......Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H......Annals of Hygiene. *m.* $2. Phila.
A J P....Am. Jour. of Politics. *m.* $3. New York.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A L ....The Architect. *w.* 26*s.* London.
A M .....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am S....American Shipbuilder. *w.* $2. New York.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A P R...Aus. Pastoralists' Rev. *m.* 20*s.* Sydney.
A R......Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
A S M E.Am. Soc. of Mec. Eng. *m.* New York.
B.......The Builder. *w.* 26*s.* London.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
B B......Brick Builder. *m.* $2.50. Boston.
B C......Boston Commonwealth. *w.* $2.50. Boston.
B D.....The Black Diamond. *w.* $3. Chicago.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S . .Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B M ....Banker's Mag. *m.* 18*s.* London,
B T J ...Board of Trade Journal. *m.* 6*s.* London.
B U W .Bul. of the Univ. of Wisconsin.
B & W. Builder and Woodworker. *m.* $1. N. Y.
C....... .Compass. *m.* $1. New York.
C A......Calif. Architect. *m.* $3. San Francisco.
Can A . Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
Ch ......Chautauquan. *m.* $2. Meadville, Pa.
C M .....Century Magazine. *m.* $4. New York.
C M R...Canadian Mining Rev. *m.* $1 50. Ottawa.
Cos.... ..Cosmopolitan. *m.* $1.50. New York.
C R......Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D.... . ."Dixie." *m.* $1.50. Atlanta.
D E......Domestic Engineering. *m.* $2. Chicago.
E.........Engineering. *w.* 36*s.* London.
E A......Electrical Age. *w.* $3. New York.

E A S....Eng. Asso of the South. *m.* $3. Nashville.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E L....Electrical Engineer. *w.* 19s. 6*d.* London.
E E N Y..Electrical Engineer. *w.* $3. New York.
E G......Engineers' Gazette. *m.* 8s. London.
E I.......Electrical Industries. *m.* $1. Chicago.
E L.......Electricity. *w.* 7s. 6*d.* London.
El.. .....Electrician. *w.* 24s. London.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y
E N......Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36s. London.
E N Y....Electricity. *w.* $2.50. New York.
E P......Electrical Plant. *m.* 6s. London.
E R......Engineering Record. *w.* $5. New York.
E Rev....Engineering Review. *m.* 7s. London.
E R L.....Electrical Review. *w.* 21s. 8*d.* London.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W......Electrical World. *w.* $3. New York.
F ....Forum. *m.* $3. New York.
F D......The Foundry. *m.* $1. Detroit.
F R......Fortnightly Review. *m.* $4.50. London.
F W......Fire and Water. *w.* $3. New York.
F'y......Fairplay. *w.* 32s. 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6s. 6*d.* Birmingham.
G & F....Garden and Forest. *w.* $4. New York.
G M.....The Geol. Mag. *m.* 18s. London.
G R......Good Roads. *m.* $1. New York.
G W......Gas World. *w.* 13s. London.
I A......Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25s. Lond
I C B....Carpenter and Builder. *w.* 8s. 8*d.* London.
I C T......Iron and Coal Trades. *w.* 30s. 4*d.* London.
I E.......Indian Engineering. *w.* 18 Rs. Calcutta.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv......Invention. *w.* 11s. London.
Ir Age..Iron Age. *w.* $4.50. New York.
Irm.. ...The Ironmonger. *w.* 10s. London.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
I W .. ..Indus. World. *w.* $3. Chicago
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila
J G L....Journal of Gas Lighting. *w.* London.
J M S I..Jour. Milit. Service In. *b-m.* $4. NewYork.
J M W A.Jour. of United Metal Workers of America. *w.* $1. N. Y.
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L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P......Louisiana Planter. *w.* $3. New Orleans.
M........Machinery. *m.* 9s. London.
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M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M E......Marine Engineer. *m.* 7s. 6*d.* London.
Met W...Metal Worker. *w.* $2. N. Y.
M G......Manufacturer's Gazette. *w.* $3. Boston.
Mill......Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Min W..The Mining World. *w.* 21s. London.
M J. ....The Mining Jour. *w.* £1. 8s. London.
Ml N....The Monumental News. *m.* $1. Chicago.
Mo ...The Monist. *qr.* $2. Chicago.
M R .....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M W.....Mechanical World. *w.* 8s. 8*d.* London.
N....... Nature. *w.* $7. London.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C......Nineteenth Century. *m.* $4.60 London.
N C B...National Car Builder. *m.* $2. New York.
N E M...New Eng. Magazine. *m.* $3. Boston,
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N S R....The New Science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6.N.Y.
P.........Paving. *m.* $2. Indianapolis.
P A .....Progressive Age. *s-m.* $3. New York.
P E C P.Procd. Engineer's Club. *q.* $2. Phila.
P Eng...Practical Engineer. *w.* 10s. London.
Pl D .....Plumber and Decor. *m.* 6s. 6*d.* London.
Pr.......Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J...Railroad Car Journal. *m.* $1 New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R M.....Roller Mill. *m.* 50 cts. Buffalo, N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7s. London.
R R......Railway Review. *w.* $2. Chicago.
R & T...Roofer and Tinner. *m.* $1. N. Y.
R W.....Railway World. *m.* 5s. London.
Ry T.. . The Railway Times. £1. 5s. London.
S .. ..Stone. *m.* $2. Chicago
S A......Southern Architect. *m.* $2. Atlanta.
San......Sanitarian. *m.* $4. Brooklyn.
Sc........Science. *w.* $3.50. New York.
Sc A ....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col.
Sea......Seaboard. *w.* $2. New York.
S Ec.....Social Economist. *m.* $2. New York.
S In......Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L......Steamship. *m* Leith, Scotland.
S M.....ScientificMachinist. *s-m.* $1.50. Cleveland, O.
S M Q....School of Mines Quarterly. $2. N. Y.
So L .....Sou. Lumberman. *s-m.* $2. Nashville.
S R . ..Sanitary Record. *m.* 10s. London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P......Sanitary Plumber. *s-m.* $2. New York.
S R G ...Street Railway Gazette. *w.* $3. Chicago.
S R J ...Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V......Safety Valve. *m.* $1. New York.
T ... .Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
Tr... ...Transport. *w.* £1. 5s. London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E......Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

Mr. Arthur Rotch, Architect.

THE *Architectural Review* devotes considerable space to an obituary notice of Mr. Arthur Rotch, who was a Boston architect of large practice, but whose name will be remembered longer for what he has contributed toward the general advancement of the profession, than for the special architectural work he has done. In connection with other members of the Rotch family he founded what is known as the Rotch Traveling Scholarship and he left munificent legacies to the Boston Architectural Club, the Boston Museum of Fine Arts, the Architectural Department of the Massachusetts Institute of Technology, and to the Architectural Department of Harvard, in founding which he largely assisted.

The article named is, however, valuable not so much on account of its mention of the services rendered to the profession by a man of lofty and liberal mind (though this may perhaps be of service in stimulating like liberality in others), as in what its author has to say in connection with this, touching the obligations of architects toward draughtsmen in their employ.

> We believe that the obligation of the architect towards his draughtsmen does not cease with the payment of the latter's weekly stipend. Setting aside moral obligation as a term too vague to have any specific application, we think it may be shown that it is for the architect's benefit to aid in every reasonable way his draughtsman's education. It will be found generally true that the architects who have attained eminence have either had a liberal education in early life, or have by singular diligence made up the deficiencies of their education in all lying outside their profession of architecture. The principle is laid down "that architecture is a means of expression, and only that," and it seems to the reviewer that if this be denied the denial would imply away all that is comprised in architecture considered as an art as distinguished from building considered as a trade. A man may be able to execute fine drawings, to imitate what others have done,—in short, may be an efficient assistant in the office of an employing architect, without being himself an architect; but when it comes to the expression of ideas and conceptions the writer of the article under review very pertinently remarks: "Except a man have something to express, all his facility is but a poor and unprofitable achievement."
>
> The importance of a good acquaintance with the standards of other arts, of literature, history, and social life, is apt to be underestimated by the beginner in architecture who comes early to his task. There is so much that appears of immediate and urgent importance for him to acquire,—technical ability of hand, the training of the eye, a knowledge of the conventional forms of design that he sees so readily employed by those above him,—all these things he wants to become proficient in; and the keener his ambition, the more undivided his attention to them. Thus it happens that many draughtsmen whose early training has not developed in them a wide interest in the things that tend to make men broad in judgment, and cultivated in choice, go for years happily pegging along in a narrow routine of study, only to discover at a fatally late day that they have been missing much that was best in the opportunities of the past.

The value of many things in influencing taste is suggested in conclusion. The sources of mental refreshment and cultivation that each man finds especially helpful may be communicated to the student, and a train of delightful results may follow of untold value. "It is only setting wide the door and inviting him in; it doesn't seem much, but it is a great deal."

Rambling Sketches.

MR. THEODORE OSCAR FRAENKEL, traveling for his health under advice of his physician, and finding absolute rest irksome, disobeyed the doctor's injunction, and amply provided with sketching materials, made sketches and notes, from which he has written for *The Inland Architect* an article describing and illustrating what he saw. The sketches are of examples of colonial architecture, such as could be seen on a southern trip, taking in Baltimore, Washington, Georgetown, Alexandria, and other cities. Speaking of the quaint old town of Alexandria, Mr. Fraenkel says:

> It is a blessing for the old place that it has

not grown faster; for there would be little left to interest one except the historical spots made famous by our forefathers. By all means keep the quiet architecture in the town if you want to keep the place. The present fashion of continental hats and capes seems quite in keeping with the old place and very pleasing to the beholder. I wandered about the grand old spot, Mt. Vernon, with its innumerable accessories, kitchen, servants' quarters, spinning house, carpenter shop, well-house, all separate from the main building, and built in Colonial feeling. The interior of the building shows the old Colonial work of Washington's time and furniture of the period, loaned by the different states.

A sketch of Christ Church in Alexandria shows one of the specimens of church architecture characteristic of the colonial period, of which a few yet remain here and there. In looking at it one easily fancies the Sunday morning scene, when the old-time Virginia planters assembled under its broad porch, while the bell in the tower at the corner of the building rang out over the adjacent fields of corn, wheat, oats, and tobacco. The sketches made in other places as the artist journeyed along will recall much that previous travelers have found interesting. A sketch of an old house in Covington, Kentucky, with its two broad verandas extending the entire length of the building on opposite sides, reminds one of the comfort and hospitality that were characteristic of southern mansions in *ante bellum* days. The building seems a standing invitation to enter and partake of the feast of good things always spread on the tables for welcome guests, visiting these old Kentucky homes. Mr. Fraenkel says he does not want to be understood as preaching "Colonial," but he maintains "that there is a lesson in the old work," and that "the impression of it was received almost direct from good work on the other side of the water." He speaks of the old work in New Orleans, mostly to be found in the French quarter, as a great attraction to people from the North. The natives call it "Spanish Colonial."

"There is a certain honesty of purpose in the Colonial. Its symmetry and balance in most everything we find it difficult to reproduce, because of the different modes and ways of building, the materials used, and principally the radical change in planning our homes at the present time. Naturally enough, every time Colonial work is attempted we are apt to design in Renaissance, which is certainly traveling in the right direction. Colonial itself is only a license to do what we want, and this freedom we can use in domestic architecture. It is just that freedom that an American architect wants, but the trouble so far has been, we have had too much. Some who have never had the opportunity of visiting the old places would find it delightful recreation, and would see there something in architecture that is truly American in spite of all our efforts to produce something new for our homes."

A certain picturesqueness always attaches to the old home life of the South, and this was reflected in its architecture, not only in the cities but in the country homes of the planters. If there ever was a house that seemed to smile a friendly welcome to those approaching it, it was an old colonial mansion. If we have gained anything by more recent types of construction, we have sacrificed this noble attribute of a home. There is a sort of "keep-off-the-grounds" expression to the more pretentious designs of recent country mansions. Many of them are beautiful, but they do not seem to invite approach. The old colonial mansion seemed to say "walk right in, tarry awhile; rest here"; and he who accepted the invitation, if worthy of the hospitality thus extended, was never disappointed. Those who read Mr. Fraenkel's article, and who can remember the South as it was even forty years ago, will recall this feeling and will find much pleasure in recalling it.

The New Style of Architecture.

C. BRYANT SCHAEFFER, in the September number of *The Inland Architect*, writes in the same line of thought as that which runs through his article on the Origin of Gothic Architecture, reviewed in this department of our October number. The same esoterism pervades what he has to say upon this subject as was noticed in his former article. If it were desirable to avoid this, it could hardly be avoided in following out the line of thought adopted;

and as Mr. Schaeffer is evidently not writing for the laity, but presumably for architects of high attainments, he is justified in soaring a considerable distance above the heads of common people.

> " How are we to arrive at a new style of architecture? It is a query that is becoming more classical than the solution. Each interrogator dwells at length upon the perplexing circumstances that are true enough, and when auditors have reached the lowest possible depths of despondency, a set of expedients, rules, or guides are produced, which are warranted by their originator to bring about speedy realizations. Some foam is thrashed and some bubbles rise upon the air that glint with color, but a little whiff and they are gone.
>
> " Possibly it is too often overlooked by the architectural enthusiast that rules came after art epochs and never before, and also that æsthetic expression does not exercise in the neighborhood of disputation. The widest course is in a close contact with the inspirational development of the common, middle-class world and faith that the mysterious question is already solving itself upon the boards of the architectural designer.
>
> " All architectural styles have unconscious beginnings. The roots have been long hidden from view when the art has become architecture. The starting, deep down in the shadows of primordial man, first records sensations that are a revelation to the human."

The author repeats his proposition that there are only three great schools of classic architectural art, namely, "the Mohammedan, Greek, and Christian styles,"—the first, effeminate; the second, masculine; the third the gothic, which he makes synonymous with "Christian." "The persistency of man in search of the higher planes of human possibilities sent the pinnacles of cathedral art skyward from the fields of Europe." The Byzantine, Romanesque, Roman, and other styles, which the author holds to be "departures from Saracenic and Greek arts," and variations of the Gothic among Venetian and French developments are regarded as representing transitional phases of civilization.

The author, in conclusion, asserts that the origination of a new style depends upon giving "to the human consciousness a necessary fourth principle"; and he implies a doubt that the depth at which architectural art has its foundations is sufficiently recognized.

The Academy at Athens.

THIS building, which we are told was intended for a body of scholars modelled after the celebrated Institute de France, and which "was erected at the expense of the late Baron Sina, a wealthy Greek of Vienna, from the designs by Hansen, a leading architect of the same place," and constructed under the direction of the architect, Ziller, who practises in Athens, is made the subject of illustrated description contributed to the *Architectural Review* by Mr. Thomas A. Fox. The illustrations are exceedingly beautiful, and the descriptive text gives a charming account of a modern building comprising, as far as possible, the features of classical Greek architecture.

> There are few modern structures which possess greater interest for the student of classic architecture than the academy at Athens, for it is a building constructed of marble from the same quarries as the Parthenon, and enriched with decorations in polychrome carefully studied from the examples of the best period, which lay close at hand. It is from this building, therefore, if from any standing at the present time, that we must judge of the effect of the Greek temple in its perfection, with its white surfaces and brilliant decorations in red, blue, and gold. For no one can doubt, in view of the recent discoveries, that the Greeks used color with a lavish hand on both sculpture and architecture.

Besides being a most interesting study in itself, the building forms one of the most remarkable groups of buildings in modern Athens, to-wit: the Academy, the University, and the Library. It gives one a curious feeling of incongruity to notice in the foreground of the front view of the Library building, which is one of the illustrations, the ubiquitous telegraph pole, rearing its modern ugliness of cross bars and insulators before a building of classical beauty. The old and the new thus brought into juxtaposition, seem each wholly unfitted for the presence of the other.

The author regards "the polychrome decoration of the exterior as the most interesting feature of the building; red, blue and a generous amount of gold having been used with most successful results." A description of this decoration concludes the article.

The Angle of Content.

PARAPHRASING the technical term "angle of repose" for a title, a writer who signs his initials H. H., has contributed a pleasant article to *The American Architect* upon designing a small country house. However small may be the technical value of this paper as an aid in architectural work (and probably its author would not claim much for it in this way), it is suggestive and expressed in delightful language. The writer, if he does not recount an actual experience of an attempt to select a type, and upon this type to design a small country house, imagines such an attempt, and paints it so vividly, and with such a vein of quiet humor, that he makes sure of any reader who, attracted by the unique title, peruses the first paragraph.

He represents himself as having long considered the requirements. He now knows exactly what he wants.

> On the first floor, there must be a large living-room, twenty feet by thirty feet. The windows are to be broad and the ceiling low. On one of the longer sides, a generous fireplace; opposite, a succession of low windows opening on a fine prospect, preferably to the west or southwest. A broad hall. A dining-room, fifteen feet by twenty feet, and the necessary pantries and kitchen Further, there is to be a small entrance porch, and in addition, a wide living porch on another side of the house. This latter condition is important; it provides that the family group shall not be disturbed by every chance visitor. Upstairs, I want four chambers, perhaps fifteen by twenty feet, and a good-sized bath-room. Then in the attic, there is to be a trunk-room, a work-shop and a servant's room. I will have no store-room. They are immoral institutions, tending to the accumulation of useless rubbish, and the withholding from your poorer neighbor of much stuff that will be of benefit to him! In this ideal household of mine we give away everything we cannot use. This induces a benevolent feeling on our part,—and makes house-cleaning easy.

But he finds it takes time to evolve the house. After all the requirements named are duly fixed upon, the exterior bothers him. After he has carefully considered types, in doing which he goes over the whole category of styles, the Colonial, Early English, Anne Hathaway, Italian, etc., he fixes at last upon the châlet. Throughout this imaginary ramble in search of a style, the author treats us to many agreeable bits of humorous reflection.

> "I am fortunate in knowing exactly what sentiment I wish my house to express. I am at great trouble to find out how to give the sentiment adequate expression. We of the laity do not often state the problem so plainly. This is the reason we get on so badly with our architect. Sentiment is vague. There is little practice in the art of expression. We fail to catch our inner motive. We fail to communicate it. As a result our architect succeeds in producing something that pleases neither himself nor us. We vote him a dull fellow after all, and lament the days of the old masters."

But he makes progress, by adopting the method of exclusion, and finally decides, as has been said, upon the châlet. Here he meets with yet a final difficulty. "It is with the angle of the roof." This gives the clue to the author's choice of a title for a most entertaining article—the angle of the roof of his imaginary châlet.

> "But the final difficulty still remains. It is with the angle of the roof. In a châlet everything depends upon this. If the roof is too steep, the house has an upstart look, as if the sides had been smashed together in bringing it from Switzerland,—just what I do not want. If the roof is too low, the effect is depressing and there is total loss of self-respect, also just what I do not want. I have tried all angles. I have studied photographs. I bought large sheets of manilla paper. I have covered them with elevations of all sorts of châlets. It has taken a prodigious amount of work. But at last I have succeeded. I have just found the right angle,—the angle of content. I am rejoiced. I shall not celebrate by killing a hundred oxen. Times have changed. I shall go to the Symphony concert instead. For the rest, it is all plain sailing. I shall leave the details to my architect. He is not such a dull fellow, after all. But I shall watch him, goniometer in hand.
>
> "It occurs to me that I have omitted to tel

what I found the angle to be. Perhaps this is just as well, however, for if one did not agree with me, one might be disposed to discredit all the other wise things I have been saying, and that I should much regret."

Home in the Cottage.

"IN spite of all that circumstance has done to create distinctions of class amongst the human race," says the *British Architect*, "the minds and desires of mankind seem to be pretty generally the same the world over. Apparently one man gets the advantage over another by a bit of extra wealth, a more liberal education, or a better bringing up, but beyond this human nature shows little or no difference between high and low, rich or poor. The joys and sorrows of the one are those of the other, and to both there comes times of longing desire when the need for bodily rest and mental quiet craves satisfaction."

There can be no denying the fact that the home itself must to a greater or less extent always influence the lives of its occupants, though it by no means follows that the most beautiful make the most beautiful lives. But convenient, comfortable, cleanly homes, with something of artistic simplicity and finish about them, at any rate make for the refinement and elevation of heart and life; this at least goes without saying. To the rich and fairly well-to-do folks the provision of comfortable and artistic homes is a matter of individual taste and personal effort. To the poorer portion of the community there is practically no choice left but to take such as they can obtain and make the best of them. For this latter class, whose homes are strictly limited to the cottage, properly so-called, or artisan's dwellings, the landlord and property owner is the only hope, and a very forlorn one it is, generally speaking. Just now and then one comes across a bona fida attempt to make the cottage, or the small house, something better than the average hut-like arrangement that usually passes muster for the artisan, and the often more poorly-off city clerk. Such an attempt we noted in a small Surrey village last week, where perhaps one might least of all have expected to find it. Almost hidden behind the great hedgerow skirting the main road, just the red-tiled roof of a row of new cottages, with their rough-cast chimneys, with red-brick finishing, first peeped over. Then through an opening in the hedge we got a full view of one of the cottages with its creamy-yellow rough-cast walls, its trim little casement windows, and the cosy-looking porch, making up as satisfactory an exterior as we ever remember having seen on such very small property. The timber work of the porch, coated with Stockholm tar, and the grey color of the door set in a frame painted white, make up an admirable effect with the color of walls and roof.

The article then proceeds to give some interesting sketches and descriptions of the cottages spoken of, the home feeling, conspicuous in what has been quoted, being the keynote of an exceedingly readable article.

Cement and Concrete Construction.

MR. ROSS F. TUCKER has contributed to *The Brickbuilder* an excellent practical paper on cements and concrete construction as applied in engineering works. The author discusses the composition of various cements in detail, under the assumption that the constructive value of cements depends very largely upon the variation in the proportion of the elements that compose them. He also calls attention to "the manner in which we may progress in the study of cements from their simplest form as they exist in lime mortar to the complex hardening of the best Portlands." The author explains by reference to a preceding paper printed in the same publication that "the hardening of a cement is due to a chemical union between two and often three primary substances—lime, silica, and alumina,—and that as far as the formation of the concrete is concerned, it is of no consequence whether this union takes place in a few hours or continues slowly through hundreds of years."

The author therefore begins the discussion with the consideration of lime mortar "which though not ordinarily called a cement, inasmuch as it shows none of the qualities belonging to a real cement within ordinary limits of time," ultimately "results in a hard compound in all respects similar to a cement."

The length of time required to bring this about depends on the quality of the sand used in making the mortar; and with ordinary sand which contains little soluble silica, the process may continue for centuries, while with pozzolanas, which are rich in soluble silica, the hardening is of sufficient quickness to warrant the use of these mortars in damp localities and even under water.

The hardening of lime mortar, practically considered, being due to the absorption of carbonic oxide from the air, the author proceeds at once to that kind of lime mortar "which shows distinct setting properties; namely that made of pozzolana and those remarkable sands used so extensively in the buildings of Rome." Of pozzolani, and other similar sands that unite quickly with nascent lime, it is stated that they are variable in quality, some being more adapted to use in wet localities than others. "The santorin earths are especially noted for their power of conferring hydraulicity upon fat limes, while trass has been extensively used in Holland in submarine works of importance." A comparison of the elements of different pozzolanas, is made. Pozzolana of Rome contains in 100 parts 48 parts of silica; 14.3 of alumina; 3.9 of magnesia; 10 of oxide of iron, 7.7 of lime; 4 of alkalies; 3 of sand, and of water, 9, 1. Santonin earth and trass are both richer in silica, alumina and alkalies, than the Roman pozzolana, while they contain neither sand nor water. Trass contains more lime than either of the others, and santonin earth less. "The union that takes place is precisely the same one that occurs when Portland cement is wet, namely the formation of a complex double silicate of lime and alumina; so that in the making of concrete the ultimate results are similar whichever process is used."

From these cements that have no distinguishing qualities as cements uutil their component parts are brought together in mortar, the author proceeds to a second general class—those which have an individual existence as cements, and are used as such; and he also subdivides this class into two kinds, the natural and the artificial. In the first of these subdivisions he places all the so-called Roman cements as used in England, all hydraulic limes as found in France, Belgium, and the shores of the Mediterranean, and the Rosendales, which have extended to America."

After a discussion of the qualities of these cements he passes to the second subdivision, which he treats under the head of "Portland Cements." Of the German Portland cements he says they are the finest in the world, in all respects; and an engineer may be at ease when his work is being done with these standard cements." English Portlands are inferior in that they "are more variable, coarser ground, and less economical." He says the processes of manufacture differ widely in the two countries, and possibly the characteristics of the two nations are shown in the results of their work. American Portland the author does not hold in high esteem.

"The Portland cements of American manufacture have a long road to travel before reaching the standard of excellence achieved by our rivals across the water; but with the great quantities of material suitable for this work at hand, it is only a question of time when American ingenuity will devote itself to the production of a domestic cement of equal quality of any in the world. The writer is not aware of the existence of a cement plant in the United States in which the production is carried on precisely as in Europe, nor is the name 'Portland' justly assumed by a great majority of American cements. It is doubtless true that several grades of domestic cement have attained a high standard and are suitable to use in important work, but they are few; extraordinary care must be observed in their use, and every precaution taken to guard against variation, for, until that is absolutely overcome, no cement can hope to take precedence of those excellent products which by long and successful use have proven themselves worthy of the highest regard, and which have won for themselves the first place in the confidence of professional builders."

Preservation of a Relic.

A CORRESPONDENT of the *British Architect*, in a note too short for indexing, writes of a project for rescuing one of the most interesting of the ecclesiastical memorials of Sussex. This relic is the pre-Reformation Vicarage or clergy-house adjoining the church of St. Andrew, colloquially known as the "Cathedral of the South Downs," which is the parish church of Alfriston, three or four miles to the northeast of Seaford, and in a district dear to the hearts of antiquaries. The house is a modest, half-timbered edifice of the fourteenth century, apparently of contemporary date with the church; and is constructed of oak framing, with the interstices filled in with "wattle and dab." In plan it consists of a central hall, 23 feet by 17 feet, the entire height of the building, with an open-timbered roof with large cambered tie-beams and molded king-posts, after the manner usual in the ecclesiastical buildings of Sussex.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review Other abbreviations are, Ill=Illustrated; W=Words.

*24947. Uses for Terra Cotta in Modern Buildings. Ill. George M. R. Twose (E Mag–Nov.) 3000 w.

*25001. Uninhabitable Houses in Glasgow (A L–Aug. 31.) 3000 w.

25036.—$1.50. Notes upon Testing Building Stones. F. Lynwood Garrison, with Discussion (T C E–July.) 3500 w.

*25061. The Limestones of Indiana. Maurice Thompson (S–Sept.) 1400 w.

*25156. Furnishing Colors. W. T. Coghlan (I C B–Sept. 7.) 1100 w.

25177. Colonial Architecture in Western Massachusetts. Ill. G. C. Gardner (A A–Sept. 15.) 2500 w.

25178. The Problem of Waste. Warren A. Rodman (A A–Sept. 15.) 1500 w.

25181. Grading Yellow Pine Finish (D–Sept.) 1100 w.

25207.—75 cts. Mr. Arthur Rotch, Architect (A Rev–Vol. III, No. 3.) 1200 w.

25208.—75 cts. Charles Bullfinch. Ill. Charles A. Cummings (A Rev–Vol. III, No. 3.) 2200 w.

25209.—75 cts. The Academy at Athens. Ill. Thomas A. Fox (A Rev–Vol. III, No. 3.) 1200 w.

25245. Mediæval Roof Tiles (R & T–Sept.) 1000 w.

25246. Pediment Chart. Ill. W. N. (Met W–Sept. 22.) 1500 w.

*25278. Home in the Cottage. Ill. (B A–Sept. 7.) 1400 w.

†25283. Rambling Sketches. Ill. Theodore Oscar Fraenkel (I A–Sept.) 2300 w.

†25284. That New Style of Architecture. C. Bryant Schaefer (I A–Sept.) 1200 w.

25286. The Angle of Content. H. H. (A A–Sept. 22.) 2200 w.

*25343. Church Doors (I C B–Sept. 14.) 700 w.

*25344. Wren and St. Paul's (I C B–Sept. 14.) 1900 w.

25414. The Expansion of Masonry. Ill. Fr. von Emperger (E N–Sept. 27.) 2500 w.

25463. The Carlisle-O'Rourke Correspondence (A & B–Sept. 29.) 2000 w.

*25478. The Housing of the Agricultural Laborer (B–Sept. 22.) 5500 w.

*25487. Wood Carving (I C B–Sept 21.) 1100 w.

25578. Notes on Stable Buildings in London. C. H. G. (A A–Sept. 29.) 1400 w.

*25726. Commercial Design (I C B–Sept. 28.) 1900 w.

*25731. The London Building Act, 1894 (A L–Sept. 28.) 6000 w.

*25732. Wall Thickness under the Building Act, 1894 (A L–Sept. 28.) 1400 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (A & B–Began May 6, 1893—34 parts to date—15 cts. each).

18737. The Engineering of Architectural and Building Construction. William H. Burr (E R–Began Jan. 6—7 parts to date—15 cts. each).

18857. Electrical Science for Architects. Ill. Russell Robb (A A–Began Jan. 13—6 parts to date—15 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Pl D–Began March—7 parts to date—30 cts. each).

21618. Bay Windows and Oriels. Ill. F. Jerman (I C B–Began April 20—9 parts to date—30 cts. each).

23626. The True Principles of Pointed or Christian Architecture. Ill. A. Welby Pugin (A L–Began July 6—Ended Aug. 31—9 parts—30 cts. each).

24273. Arkansas Marbles. T. C. Hopkins (S–Began Aug.—2 parts to date—30 cts. each).

25147. Electric Power, Heating and Lighting, with Demonstrations and Notes on Their Possible Influence on the Architecture of the Future. G. Binswanger (Inv–Began Sept. 8—Ended Sept. 29—3 parts—30 cts. each).

25332. Mortars: Ancient and Modern. Fred T. Hodgson (A & B–Began Sept. 22—2 parts to date—15 cts. each).

25485. The Church Organ Architecturally and Archæologically Considered. Ill. (Abstract.) Arthur G. Hill (I C B–Began Sept. 21—Ended Sept. 28—2 parts—30 cts. each).

25577. The Influence of the Hanseatic League) on the Architecture of Northern Europe. J. Tavenor Perry (A A–Began Sept. 29—1 part to date—15 cts).

25703. Tall Office Building—Past and Future. Dankmar Adler (L A–Began Sept.—1 part to date—15 cts).

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

A Criticism of the Experts' Estimates of Cost of a North River Bridge.

IN a recent letter to Mr. H. Schwab, Chairman of the Committee of the New York Chamber of Commerce on North River Bridges, Mr. W. Hildenbrand has criticised the comparative estimates submitted by the Board of Expert Engineers in their report upon Proposed Hudson River Bridges; and *Engineering News* (Sept. 13) in its customary able way of doing such work, has printed an excellent abstract of the letter. It is a well-known fact that engineers were not unanimous in approval of the report in question; and many of them will be inclined to side with Mr. Hildenbrand in the controversy thus opened, though perhaps not agreeing with him on all points. The criticism relates more especially to the "figures for weights, condition of loading, and price of material."

While conceding the general fairness of treatment of the subjects of the report, Mr. Hildenbrand makes the contention that the report has exaggerated the weights, put dimensions above what is actually required, and, to quote our contemporary, "assumed more severe conditions for live load and working stresses for the suspension bridge than for the cantilever."

It is asserted that the board itself acknowledged that it had assumed prices which were too high, evidently with the object of keeping on the safe side. Many have been impressed with the extremely cautious and conservative tone that pervades the report.

Viewed in the light of the maximum cost of a suspension bridge, no comment would be necessary, says Mr. Hildenbrand; but as a comparative estimate between two structures, one of which was estimated from previous careful and time-absorbing calculations, it is only fair that that structure should have the benefit of all possible accuracy, and acknowledged existing favorable facts should be fully considered.

When it is here added that Mr. Hildenbrand has gone over the calculations with due consideration of the modifications suggested in the report, and that in computing the weight of the stiffening truss of the suspension bridge, for the part of the load which it actually distributes, instead of computing it as distributing the entire load as is done in the report, he finds that the actually live load will be 15,000 pounds per lineal foot instead of 18,000 pounds, and that the cost of the bridge would be $2,634,000 less than the report estimates it; and when it is further stated that the letter from which the abstract is made has been submitted to the Secretary of War by the New York Chamber of Commerce, the importance of the criticism will be comprehended. But something more must be said to give an adequate idea of the force of Mr. Hildenbrand's criticism. After going over the data necessary to a final computation and comparison of cost, for which the article must be itself consulted, he arrives at the following conclusions: "The heaviest 3200-foot suspension bridge would cost only $2,600,000 more than the 2000-foot cantilever, and a lighter 3200-foot span suspension bridge fully safe and practicable could be built for $2,000,000 less than the 2000-foot cantilever bridge."

The Waterway from Chicago to the Gulf.

THE September number of *Milling* discusses what it regards as "the most important public work now being executed in the world," under the title "The Waterway from Chicago to the Gulf via the Illinois and Mississippi rivers." The article is prompted by the September excursion of the Western Society of Engineers to the work on the canal, the guests including a representative of the magazine named. After describing the personnel of the party and other interesting details of the excursion, the article proceeds to give some interesting particulars of the work itself. It states that the work has gone steadily on, notwithstanding the panic and social disorder which has paralyzed business both east and west. It lays down as a proposition with reference to "all further canal construction" that "railroads cannot compete with water-carriage in hulls of 1000 tons or over. That is the limit of their economic endurance. In no instance have railways won against deep interior waterways. The day of small trunk canals is over; that of deep wide channels is recognized."

The writer alludes to the fact that 'Canada has so far led the United States in waterway construction. "In time of war it would be feasible for Great Britain through the canals of this progressive province to put upon the lakes naval forces which we have not the conditions to meet; but when this Chicago work is completed, without violation of existing treaties the United States will be enabled to more than offset the very large advantage which Canada now possesses."

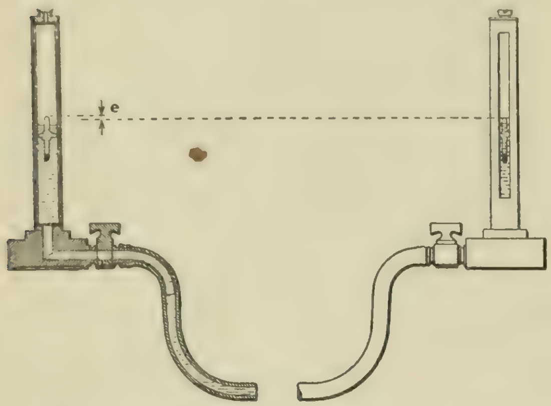
Reference is made to the effects upon sanitation of inland towns situated along the projected canal, and the writer says that this has been a source of constant solicitude. He holds, however, that there is no other solution to the drainage problem for Chicago. With reference to St. Louis and other interior towns the author thinks that the great constant current from Lake Michigan will alleviate the effect of constant growth of cities and towns draining into the Desplaines and Illinois rivers upon the potability of their waters.

The economical advantages to Chicago and the people along the sixteen hundred miles to the Gulf from the construction of the canal will be incalculable. General Poe, in charge of the twenty-foot waterway improvement of the lakes, is authority for the statement that the saving to the public in 1890 alone was $135,000,000—two-thirds of all the expenditures of the government upon rivers and harbors up to date. Water-carriage adds but six and a half per cent. to the average value of goods, while railway freightage adds forty-five per cent. Who can doubt that this explains the enormous relative increase of wealth and population of deep lake ports—over Cincinnati, Louisville, St. Louis and New Orleans? A fourteen-foot waterway to the Gulf, if it follows the precedent of lake development, will be lined with manufacturing towns, supplying the wants of near consumers. The South especially will receive a commercial impetus. The increased demand upon her forests alone will bring hundreds of cargoes of lumber and ties yearly to Northern markets.

An anticipation of the effects which will result from the opening of this new avenue of communication is the topic of a very interesting concluding paragraph. Among these the impulse to ship-building and the increase of national security "through the adding of our lake ship-yard plants to those of the coast for the building and repairing of armed vessels" are among the most important, and the writer thinks the new route by way of the Gulf will become a strong competitor in the hands of lake ship-owners for much of the grain and provisions now transported by way of the St. Lawrence and the Erie canal.

Instruments for Testing Bridges.

An excellent abstract of an interesting paper read at a meeting of the Verein fur Eisenbahnkunde, by Mr. Leschinsky, which treated of the present status of instruments for testing bridges, was printed in the *Railway Gazette* (Sept. 28). This abstract starts with mention of the difference of opinion among engineers relative to the life of well cared for bridges, and the statement that "the great cost of iron bridges renders it important to determine as exactly as possible when a structure ought to be rebuilt." Various methods and instruments for determining deflection are then noticed. A frequently employed but inaccurate method is described. "A piece of paper on a board is fastened to the truss in the center. Against it is placed the point of a pencil stuck through a vertical plank alongside, and the point describes a vertical line on the paper when the bridge deflects under load." An improvement upon this method is then mentioned which does not, however, secure the desired accuracy. Other methods named are the use of a revolving paper cylinder upon which tracings indicating deflections are produced, and the use of a wire fastened to a sufficiently heavy weight and running over a sheave that moves an index over a graduated sector. The faults which are met with in the use of these appliances are stated to arise from a variety of causes, which are named. The Wienhold, and the Fuchs apparatuses are then described, and the causes of inaccuracies in their use are pointed out. Many important points relating to what is needed in testing the safety of bridges are alluded to, and the requisites of an apparatus for this purpose are summed up as follows:



SEIBT'S BRIDGE TESTING APPARATUS.

"A thoroughly suitable instrument would have to fulfill about the following requirements: It must be simple and, if possible, without adjusting screws. It must be applicable without difficulty on all large and small, old and new bridges. It must be for the determination of the deformation of a chord, and also the changes of levels of all panel points with and without loading the bridge. The measurements must be possible without a staging, and must allow checking of results."

The apparatus of Dr. Seibt which is alleged to meet all the required conditions is then illustrated and described. For the purposes of this review the cuts illustrating the text were loaned by the paper quoted. The apparatus and the manner of using it, are thus described:

"It consists of two vertical glass tubes, connected by a thick rubber hose of ½ inch diameter and 52 feet length, the tubes partly filled with distilled water. In each tube is a float of black glass weighted with quicksilver. The elevation of the floats is read by means of a slotted and graduated tube slipped over the water tubes, on which slides a sleeve vernier. The top of the slot in the sleeve and the top of the float are adjusted to the same elevation which is then read. The two floats do not sink equally deep into the water. To ascertain the error it serves that the shoulder of the base of the glass tube on which rests the measuring tube has exactly the same elevation over the foot plate of each instrument. The difference of reading will give the constant error when both instruments rest on a level, horizontal surface. The instrument is used as follows: To the main trusses are fastened shallow cylinders, Figure 2, about 40 feet between centers. The cylinders have two studs which fit into recesses in the base plates of the tubes, thus preventing them from sliding off. Leveling from cylinder to cylinder along one truss and back by the other to the starting point, that is, from a to b, c, d, e, f, Figure 3 letting always the same glass precede, the test of correctness can be made by subtracting the sums of readings of one glass from that of the other glass. The difference must be zero, considering the index error e, which has to be multiplied by the number of readings. The accurateness of this instrument is 1-250 of an inch."

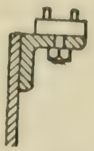


FIG. 2.

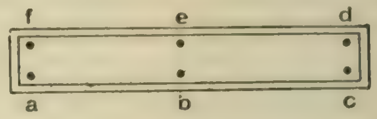


FIG. 3.

Ship-Canals, Ancient and Modern.

THE history of ship-canals, rather than the principles involved in their construction and operation, and their constructive details, is given in an article printed in *Western America.* The article has been written from materials accessible in encyclopædias and historical records, with added information collected from more recent engineering publications relating to ship-canals now in process of construction or projected.

The writer (the article is unsigned) claims that Americans do not appreciate the advantages of ship-canals, as commercial routes, as much as Europeans. If this be so, the greater number of natural waterways available for navigation on this continent might well account for the fact, since up to the present time these, together with our great railway systems, have afforded enormous facilities for transportation of products.

The history of ship-canals dates back to the Pharaohs of Egypt, in whose time, and subsequently by Ptolemy, an unsuccessful attempt was made to connect the Red Sea with the river Nile by a canal large enough for the passage of ships of the period. The author then gives successively, brief accounts of ship-canals, from the first successful one known to history down to the present time; the latest completed work of this kind being the lock-canal which gives access to the city of Manchester for large ships, thus practically converting this city into a seaport town, and which is considered as the greatest engineering work ever undertaken in the United Kingdom.

This canal commences at Eastham, a small town near Liverpool, and runs 35½ miles to Manchester, with a minimum depth of 26 feet, and breadth of 120 feet at the bottom. All rail and highway crossings are at a minimum height of 75 feet above the canal. There are five sets of locks with a total lift of 60.5 feet. The entire cost of the work, which was opened for traffic during the early part of this year, amounted to upwards of $70,000,0c0.

Other ship-canals enumerated in this historical résumé are the Corinthian canal, cutting the Isthmus of Corinth, the first canal large enough to admit passage of war galleys, plans for which were caused to be drawn by Nero; the Fossa Drusiana, connecting the lower Rhine with the Zuyder Zee, 12 B. C., built by Claudius Nero; North Sea-Baltic Canal, across the Danish peninsula, a German work; Amsterdam ship-canal; the Clyde, which, though originally a small stream, has been deepened and widened to allow the passage of the largest ships into the heart of the city of Glasgow, the effect of which has been to raise Glasgow to the rank of the second city in the Kingdom, and convert it into the greatest ship-building emporium in the world; the canal that, when finished, will connect the Adriatic and Tyrrhenian seas; the canal projected by France for connecting the Mediterranean and the Atlantic ocean; the Chesapeake and Delaware canal across the Maryland Peninsula, and the Sault Sainte Marie canal, or "Soo," as it is generally called.

The article is, however, by no meaas comprehensive. No mention is made of some important works completed, projected, or in progress; such as the great Suez canal, the projects and attempts to connect the Atlantic and Pacific oceans by cutting through the isthmus joining North and South America at different points, etc.; it contains, nevertheless, information that will be new to many readers. The reconstruction of the old Corinthian canal, that has long been in ruins, and which is named above as the first successful ship-canal constructed, and which has lain in ruins for centuries, is spoken of as follows:

"A great work that is steadily going forward is the enlarging and deepening of the old Corinthian canal. In 1881 Gen. Turr obtained a concession from the Greek government, and work was commenced in 1882. The new canal is to be four miles long,—an almost straight line across the Isthmus of Corinth, and with an average depth of 26 feet."

A Proposed Ship-Canal.

A CORRESPONDENT of the *Scientific American*, Mr. Irving Boardman, propounds a scheme for a ship-canal to connect the Hudson river and the great lakes, which he justly thinks has much to recommend it, as necessitating fewer locks, passing the summit at the lowest point, and as being the shortest practicable line on which such a canal could be constructed. He states the length of this line to be 166 miles, or thirty-three miles shorter than that proposed by Mr. McAlpine to the Oswego board of trade several years ago.

Our plan is substantially this: Make Lake Oneida the summit and use it as our summit reservoir, and enter the Hudson near Albany, or rather south of it, near where the Delaware and Hudson railroad curves to the west. The section extending from the Hudson inland would join the Erie canal at or near Schenectady, and would be as straight as it could be made, the distance being between these points sixteen or seventeen miles, instead of thirty, as at present by way of West Troy and the Erie canal. From Schenectady the line would follow the Erie canal to Utica. Thence a straight cut would be made to Lake Oneida, from the western end of which the canal would be excavated to Lake Ontario, joining it at or near Oswego. We avoid crossing the Mohawk by keeping to the south of it. We avoid locking up sixty or seventy feet going east from Lake Oneida, as in Mr. McAlpine's plan, by deep excavations from Little Falls, or near there to the lake, and passing beneath the "long level" of the Erie canal from sixty to eighty feet. The rise from the Hudson to Schenectady being about 200 feet, would necessitate twenty locks, and about the same number would be required from there to the point where we would reach our long level at Little Falls or near there, to and through Lake Oneida to the first lock beyond, a distance of from sixty to seventy miles. There would be needed six or seven locks between Lake Oneida and Lake Ontario. The present outlet of Lake Oneida would be closed and Oswego river would be left alone, except to feed the canal. At the points where the canal enters and leaves the lake, gates would be placed to accommodate the varying height of the water. Oswego harbor would require deepening to accommodate boats of twenty feet draught, provided our canal passed boats of that size. The prism of the proposed canal would be large enough to pass any boat that could pass the Welland canal.

He thinks the supply of water for the needs of the canal would be satisfactorily settled by this plan, as Oneida lake would supply water to pass the summit both ways. The demands west of the lake he thinks would be met by Oswego river, and east by the Mohawk river. The writer thinks this is really the only practical route for such a canal, and argues for its feasibility, though as to its cost he admits that he has made no estimate. There are points made in the scheme worth considering, though it may be that a thorough survey would develop impracticabilities not anticipated by Mr. Boardman. He admits there would need to be some very heavy excavation; but thinks none greater, or at most but little greater, than was done on the Suez canal would be required. The author alludes to the obvious advantages from having such a canal entirely within the United States. In such case the depth of the canal could be regulated to allow the passage of any vessel drawing fourteen feet, and it is stated that the bulk of ocean freight is carried in vessels drawing no more than this.

The Alignment of Tunnels.

THE important and at times difficult process of aligning different sections of tunnels in railway construction is treated editorially in *The Engineer*. The discussion is opened pleasantly by recalling a story with which tyros in engineers' offices are often entertained. This relates to a mythical tunnel of indefinite location where headings "were carried past one another instead of meeting." The story is that the mistake was discovered through the circumstance that the gang working in one heading knocked off work for dinner a little earlier than the other, and the sound of their implements ceasing, the sound of those of the men who continued working was noticed to come from the side instead of the front, thus leading to an investigation that revealed the fault. Quoting the remarks of the President of the Institution of Civil Engineers, the editorial goes on to say that since the time of the memorable occurrence narrated, which appears to have been assigned in turn to nearly every tunnel that has been constructed, "better methods of setting out tunnels have been introduced." The writer then classes the setting out or alignment of a tunnel under three heads. "First, the ranging or alignment above ground; secondly, that below, either in the heading or in the full section of the tunnel; and, thirdly, what may be called the vertical alignment, or, the transference of the surface-line to the subterranean one."

Should the tunnel, similar to the longest two existing at Mont Cenis and Mont St. Gothard, be constructed without shafts the vertical alignment is not required, as presumably the tunnel would be ranged from points observed directly from each extremity. In other words, the line of direction being given by the fixation of a couple of terminal points at any visible distance from the ends of the tunnel, the alignment may be obtained by setting up the instrument, whether a plain transit or a theodolite, over the nearest point, sighting backwards, reversing and ranging forward, or by absolutely ranging the line backwards from the fixed points. It is extremely rare that contours of the ground beneath which the tunnel is situated are sufficiently favorable to allow of one extremity being visible from the other; that is, to permit of the total length being ranged forward in either one direction or the other. The more general case is that in which, while the ends of the tunnel themselves are not sightable the one from the other, yet a summit level obtains from which as a common point, even if, as frequently occurs, the ends are not visible, points in the direction of the line of trace can be accurately determined, marked, and rendered available for the alignment of the face headings or driftways. The distance at which these points are located from the mouths of the tunnel will depend upon the physical features of the surface, but it is really a matter of little moment how far off they may be situated, so long as they are fairly within the range of the instrument employed. With this proviso, the farther off they are the better, as they admit of a more accurate and delicate adjustment by the cross wires of the telescope.

The tunnels on the Dore and Chinley Railway, were aligned by a forward and backward sighting from a summit level. Very interesting particulars of this alignment are given, and methods employed on other large tunnels are reviewed, making the article, as a whole, especially valuable to students of engineering. Statements of the amount of deviation that resulted in the execution of the work of some of the most notable tunnels, as given in the article, are as follows:

> The total deviation of the headings in the Totley tunnel was 4½ inches in every 555 yards of heading, a very satisfactory result. In the Mont Cenis tunnel, which is shaftless, the horizontal deviation is given as *nil.* But in the similar work at Mont St. Gothard, the total error amounted to 13 inches, or 1 inch in every 627 yards, assuming the "thirl" to have taken place at about midway. In instituting this comparison, some additional credit may be fairly given to the St. Gothard tunnel, having regard to its great length, which closely approximates to 9¼ miles.

Diagram for Wooden Beams and Posts.

Two diagrams for use in engineers' and architects' offices in proportioning wooden beams and posts, are given on an inset sheet by *Engineering News* (Sept. 27). These diagrams were devised by Mr. Carl S. Fogh, C. E., of Denver, Col. The paper quoted regards these diagrams as excellent examples of the rapidity and freedom from error with which computations may be made by the graphical method. Such helps are among the most valuable of contributions to technical literature. *Engineering News* says of these diagrams that they were first computed and platted on a large scale by Mr. Fogh, and then reduced for the inset sheet by photo-lithography. It is therefore believed that their accuracy may be relied upon. The principles upon which the diagrams are constructed, and full explanations of their use are given in the accompanying text, and a little study will give facility in their use. A practical trial of the method made with a view to test its value, proved that a great deal of time can be saved by the use of this diagram, while at the same time as accurate results are obtainable as any one could wish for practicable purposes.

Something may be said here with propriety upon the value of the graphical method in making such computations, which, by the way, is now being actively discussed in engineering and mechanical publications. While as time saving devices they are worthy of the highest commendation, they by no means obviate the necessity for an engineer to be an expert mathematician. Some papers appear to have placed such an exaggerated estimate upon graphic methods as to lead one to the belief that they think these will almost supersede mathematical methods. Only those not fully conversant with the resources which mathematical skill confers upon its possessor could possibly entertain such an opinion. At the same time it is undoubtedly true that where simple graphical methods can be devised, a liability to err which besets inexpert computers is removed. Hence such methods are becoming more and more popular, and new ones are constantly appearing.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

25044. A Criticism of the Experts' Estimates of Cost of a North River Bridge. W. Hildenbrand (E N–Sept. 13.) 1200 w.

*25119. The Pecos Viaduct. Ill. Julius Kruttschnitt (E A S–Aug.) 2800 w.

*25124. The Sher Shah Bridge, Punjab, India. Ill. (E–Sept. 7.) 2000 w.

25165. Construction of the Granite Viaduct. Ill. (E R–Sept. 15.) 1300 w.

25290. The Wallabout Canal Drawbridge. Ill. (E R–Sept. 22.) 1000 w.

25405. Notes on Instruments for Testing Bridges. Ill. (R G–Sept. 28.) 1200 w.

*25449. Road Bridge for Brazil. Ill. (Eng L–Sept. 21.) 3400 w.

Canals, Rivers and Harbors.

24965. Ship Canals, Ancient and Modern (W A–Sept.) 1800 w.

25045. The Proposed Ship Canal Across New Jersey (E N–Sept. 13.) 4800 w.

*25140. The Manchester Ship Canal. John Dean (J A E S–Aug.) 5500 w.

25204. The Nicaragua Canal. Chauncey F. Black (M R–Sept. 21.) 2800 w.

25232. The Anti-Canal Convention. Editorial (Sea–Sept. 20.) 1200 w.

*25261. The Panama Canal—" To Be or Not to Be ?" (Ry T–Sept. 15.) 1000 w.

25391. The Deep Water-ways Convention, with Editorial (Sea–Sept. 27.) 3800 w.

*25521. The Waterway from Chicago to the Gulf via the Illinois and Mississippi Rivers. Ill. (Mill–Sept.) 2500 w.

25542. A Proposed Ship Canal. Irving Boardman (Sc A–Sept. 29.) 800 w.

†25546. Notes on the Improvement of Philadelphia Harbor. L. Y. Schermerhorn, with Discussion (P E C P–April-June.) 6000 w.

25633. Water-Power Canal for the Niagara Power and Development Company. Ill. (E N–Oct. 4.) 700 w.

Hydraulics.

25029.—$1.50. The Cippoletti Trapezoidal Weir. Ill. A. D. Flinn and C. W. D. Dyer (T C E–July.) 6000 w.

*25448. Glasgow Weirs. Ill. (Eng L–Sept. 21.) 3300 w.

†25543. The Baptism of the Great Niagara Tunnel. Emile Geyelin (P E C P–April-June.) 3000 w.

25564. Calculations for the Flow of Water in Pipes Simplified. William Cox (A M–Oct. 4.) 800 w.

25586. A Bird's-Eye View of Niagara Falls. Interesting Data of This Tremendous Water Power. Ill. (E R N Y–Oct. 3.) 750 w.

25627. Machinery for Operating a 247-ft. Swing Span by a Pelton Wheel. Ill. (E N–Oct. 4.) 800 w.

25654. Limits to the Profitable Development of Water-Power (E N–Oct. 4.) 3000 w.

Irrigation.

24967. A Review of Irrigation.—Lessons to Be Learned. Ill. J. W. Powell (W A–Sept.) 2800 w.

24968. Irrigation—Theory and Practice. B. C. Buffum (W A–Sept.) 2400 w.

†25024. Inundation Canals. E. A. S. (I E–Aug. 11.) 2000 w.

25047. The Cession of Arid Lands to the States (E N–Sept. 13.) 500 w.

*25137. The West Gallatin Irrigation Canal Montana. Ill. A. E. Cumming (J A E S–Aug.) 3000 w,

†25360. Irrigation in the Native States of the Malay Peninsula (I E–Aug. 25.) 1500 w.

*25560. The Progress of Irrigation Thought in the West. William E. Smythe (R of R–Oct.) 3700 w.

Miscellany.

*24954. Advantages of the Tehuantepec Route. Ill. Elmer L. Corthell (E Mag–Nov.) 3000 w.

*24921. The Alignment of Tunnels. Editorial (Eng L–Aug. 31.) 2000 w.

25054. Asphaltic Cement. A. S. Cooper (Sc A S–Sept. 15.) 3500 w.

*25139. Masonry Lining at Mullan Tunnel. Ill. H. C. Relf (J A E S–Aug.) 2300 w.

25409. Diagrams for Proportioning Wooden Beams and Posts. Ill. (E N–Sept. 27.) 400 w.

25410. The Busk Tunnel on the Colorado Midland R. R. Ill. (E N–Sept. 27.) 1600 w.

*25514. The Philadelphia Asphalt Tests. Dolphus Torrey (P–Oct.) 1200 w.

*25682. Solid Rock Dredger. Ill. (Eng L–Sept. 28.) 1800 w.

Serials.

21592. The Harlem River Speedway. Ill. (E R–Began April 28—9 parts to date—15 cts. each).

22758. The Chicago Drainage Canal (R R–Began June 9—15 parts to date—15 cts. each).

23669. Centrifugal Pumps. Ill. John Richards (I S F–Began July—4 parts to date—30 cts. each).

24421. Notes on the Strength of Framed Structures as Affected by Elasticity. C. F. Findlay (Eng L–Began Aug. 10—Ended Sept. 7—3 parts—30 cts. each).

25445. The Clyde Trust Dredger " Cairndhu " Ill. (E–Began Sept. 21—1 part to date —30 cts).

25661. Module Gate. Ill. R. G. Kennedy (I E–Began Sept. 1—1 part to date—45 cts).

DOMESTIC ENGINEERING

Sanitary Plumbing.

A MOST important point as regards the relation of contracting plumbers to work executed by them is brought to public attention in an article printed in *The Architect* (London). The writer of this article claims to speak from experience when he says that the terrible havoc made from time to time through the agency of defective plumbing-work in Great Britain and America has, without proper inquiry, been attributed to plumbers, forgetting or ignoring the fact that for the most part plumbers' work is issued in accordance with specifications "which, in the majority of cases, were framed on false economy and very often in ignorance of the subject by the architect who drew them."

The article is a reprint of a paper read before the Associated Master Plumbers of Victoria by M. F. B. Brady, and first printed in the *Australasian Builder*.

"As a sample, an architect specified (where the owner would willingly pay for good work) a 4½ inch cast-iron rain-water pipe with red lead joints for vertical soil pipe from three water-closets; and to make matters worse, had it fixed in a recess in a wall. When remonstrated with, he said: 'Carry out the work as specified and I will accept all responsibility.' I merely mention this as an instance of how the plumber is blamed for defective work when the specifications distinctly give him material to use which renders it impossible to make the work secure for any length of time; and then the architect is the first to fix the blame on the plumber. I sincerely trust for the sake of all concerned that the architects of this colony will have all fixed rules and data at their fingers' end, so that incompetent and unscrupulous persons may be prevented from undertaking the execution of work which they do not understand. I consider that every architect should be sufficiently instructed in plumbing to know the difference between good and bad work in course of construction, not after."

The paper is a long one, and goes over the whole ground of materials and workmanship. With reference to protecting cast-iron soil pipes Mr. Brady says, that, while some good authorities advocate first galvanizing, and then coating with Dr. Angus Smith's solution, the unenduring character of all solutions is well known. "Although the idea looks well on paper, in a great many cases it helps to cover defects and imperfections which might exist in the pipe." From his practical experience he doubts very much the efficacy of any solution when applied to soil pipes.

"I do not for a moment dispute its qualities as a temporary resisting medium to oxidation in iron pipes, when used as a conduit for fresh water. I am at a loss to know why such good authorities prefer that cast-iron pipe should be galvanized when used for soil pipe. I am sure it requires no great reasoning to prove that the use of zinc should be studiously avoided and condemned, and no architect or plumber should allow it to be used. Now as to incrustation, I have taken down some cast-iron soil pipes which have been in use for about eight years. When I examined the amount of deposit on one side of the pipes, especially at the joints, it seemed incredible; but wherever the incrustation was greatest the pipe was perfect, although one could crush the opposite side with the fingers. No doubt the deposit formed a concrete, and protected the surface covered at the expense of the other side. I might mention that it was a medium description of a cast-iron pipe, ventilated, but improperly. At a recent convention of the Master Plumbers of New York, a section of iron soil pipe taken from a building was exhibited. The exhibit showed in a practical way the ravages made on iron pipe which was fixed, yet at the same time appeared to be in a fair state of preservation, with the exception of a deposit of rust. If required I could give several instances like the foregoing with date and place."

The author advocates the use of iron for soil pipes. He is certain it will be largely used in Melbourne in future work. As a drain pipe he would compel it to be used in all cases where passing through or under a house; for, buried in the earth, it would be free from destructive atmospheric influences; but he strongly deprecates the use of galvanized cast or wrought iron pipes for soil or waste pipes, even when disconnected from the drain. As to lead soil pipes he says:

"Now as to lead soil pipes, I have often read and heard a great deal about the incrustation on them, but in my experience I have failed to discover anything approaching the incrustation previously described as existing in the iron pipe, even when fixed under much more unfavorable conditions, viz., no ventilation. One proof of this statement: During a building alteration in the Mercy Hospital, Cork, 1881, I had to remove a stack of 4½ inch lead soil pipe which had been in position for over thirty years and was not ventilated. I was astonished at the state of preservation of the lead; the only portion that looked suspicious was the soldered seam. I cut the seam out, left the lead to dry, and when I again examined it found no sign of deposit except a small powdered substance. But the lead traps, especially the seal chamber and above it, when touched, actually fell asunder, being completely oxidized. Still I do not doubt there have been such cases of incrustation in lead soil pipes met with, but I have never seen them."

The Difference in Amount of Radiation Required in Buildings of Good and Poor Construction.

As bearing upon the recently agitated question of guarantees, given by heating contractors to owners, or, as a well-known writer has recently put it, "how far the risks of failure to heat a building ought to be shared between the owner and contractor," a paper read by Mr. E. P. Bates of Syracuse, N. Y., at the sixth annual convention of the Steam and Hot Water Fitters' Association of the United States, held in New York city in June, 1894, is very instructive.

The paper gives an account of personal experiences as a contractor in this line of business, and indicates that failure to heat buildings to a guaranteed degree in "zero weather" is often much more the fault of the constructor of a building than of the contractor who puts in the heating plant. This being admitted, it has been held by another writer on the subject, that guarantees should be mutual, and that the guarantee of the contractor that the apparatus he places in a building will heat it to a stated degree under stated conditions, shall include among those conditions that the building shall be well constructed, whether it be of stone, brick or wood. Only one interesting example given by Mr. Bates will be here quoted out of a number of equal significance.

In the fall of 1879, I placed a low pressure steam heating apparatus in a building designed for a home for old ladies. Many of the rooms were small, and in order to warm them without question a radiator was placed in each room. Knowing that a high temperature would be agreeable, the calculation was made that one foot of radiation would warm forty cubic feet of air. This we considered very liberal when the fact that we used the Gold sheet iron radiator is taken into account. We were, however, doomed to a very serious disappointment, as the temperature in the room on the windward side of the house frequently fell to 50° and sometimes even below during severe cold and windy weather. After reconsidering all the conditions we determined to add a large percentage of radiation, which was done, and the building has been thoroughly warm ever since. The amount of radiation added in many of the exposed rooms was from 50 to 100 per cent. over that originally supplied. To my mind the rooms in this building are very uncomfortable; for the excessive amount of radiation required to maintain the temperature produces a very disagreeable condition of affairs, together with the excessive loss of heat through the thin walls and many air leaks. It was soon found that, although the ratio of radiation was very excessive, under the existing conditions the condensation was very rapid, and more boiler power was required to maintain the steam pressure. Consequently an additional boiler was supplied at the expense of the heating contractor, which gave plenty of generating power, but all this was accomplished at a heavy proportional loss to the contractor. To my mind, as I review the entire matter, I find that the original calculations for boiler and radiating surface were correct, providing the building in question had been ordinarily well constructed. But from subsequent surveys I conclude that the architect and building contractor produced about as poor a specimen as it was possible to do and have it stand up as a public building. The result is that the amount of fuel needed to warm the building is enormous.

The example well illustrates the risks which contractors take in giving the customary guarantees; and as in many cases it is impossible for them to determine when making their estimates whether the building they are estimating for will be well built or otherwise, it seems unfair that all this risk should be borne by the contractor alone. The heating trade has already begun to protest against this injustice.

Irrigation of City Parks.

THE burden of an editorial article in *Garden and Forest* upon the subject indicated in the title, is the need of appliances for irrigating public parks. Much of what is said upon the subject also applies so well to private pleasure grounds as to fitly find a place in Domestic Engineering.

The position is taken that "no city park ought to be called finished until adequate provision is made for watering every inch of it."

Unfortunately there are very few public or private parks in this country that in time of drought can so effectually irrigate as to prevent injury to any part of the grounds. The article quoted cites Central Park, New York, as an exampleof miserable deficiency in means for irrigation, and says it should have an addition of from thirty to forty thousand feet of underground piping, and fifteen to twenty thousand feet of rubber hose to supplement its present facilities for watering the grounds in dry weather. Of New York city parks it says:

> As an evidence of the beneficent effects of irrigation one has only to glance at the chain of small parks in Fourth Avenue, where the shrubs are holding all their leaves, and the grass is a vivid green even on the thin soil of the tunnel. On the other hand, Morningside Park is a picture of desolation which it is painful to behold. A feeble attempt at watering the lower portion of this park has been made by attaching hose to one of the city hydrants far beyond the limits of the park, and last week we saw several men doing the best they could with a reach of hose a thousand feet long. But this is slow and ineffectual work, and it is a wonder that any of the shrubs on the rocky slopes are alive.

With reference to increased facilities for irrigation it says:

> With such a plant a very small force, working systematically, could do effectively what four times as many men are now trying to do and making an utter failure. It is easy to see how large an area one man could attend to regularly and systematically if he had the proper machinery, and how in this way a perfect record could be kept, showing just when a space had been watered, and just how much was given to it. There may have been some excuse for dribbling out an inadequate water-supply to the parks when water was said to be scarce, although there seems no reason why the city should not deal with the parks in this respect as liberally as with any similar area in its thickly populated portions. There is no lack of water now, however, and there is no one thing that Central Park and Morningside need so much as proper facilities for applying it.

Slipshod Sanitation.

IN one of the Manchester (England) Health Lectures, Dr. Noble questions why it is that in spite of the great amount of work done in recent times for the advancement of sanitary measures there has not been a corresponding decrease of sickness and of the death-rate. In the *Plumber and Decorator* (Sept. 1, 1894), W. L. Hunter, M. D., answers the question in a way that applies to American as well as to English cities. He alleges that a large portion of what is called sanitary work in city dwellings is such simply in name, and that from various causes, sanitary laws are not properly enforced.

Personal habits of diet and drink, and attention to, or neglect of personal cleanliness, have much to do with the sanitary condition of towns especially among the poorer classes; but Dr. Hunter holds that ineffective administration of sanitary regulations is the main factor in keeping death-rates up to their present mark.

> Much worse than the passing of these permissive Acts is the fact that the compulsory Acts are only compulsory in theory, and, as a fact, they are to a great extent disregarded. It is a matter of daily knowledge that a great portion of what has been called the Sanitary Charter, the

Public Health Act, 1875, is allowed to be a dead letter, and is ignored by the guardians of the public health.

An example of the loose administration of sanitary laws is found in the way vaccination is resisted and evaded.

Of this he remarks: "In some places the act is not enforced at all, and in others the one-mark, or what the Yankees would call the "one horse" system of vaccination is steadily on the increase."

As a reason for not enforcing sanitary laws, it is alleged that the public are not sufficiently educated to understand the importance of them. This seems to me rather an argument for giving effect to them. If there is any doubt about the good of a measure I can understand waiting for the development of public education; but when its utility is so fully established, there can be little objection to strictly enforcing it. The "liberty of the subject" bugbear is another plea. This cuts both ways, and it is against reason that a man should be allowed to commit manslaughter by poisoning his neighbor's family with infectious disease, or with sewer gas from his defective drains. Besides, this same delicacy for private feeling is not shown so strongly in other matters, *e. g.*, in the collecting of rates and taxes, or in the stamping out of cattle diseases. These inefficient laws are frequently made less effective by the conditions under which they are administered.

The article goes on to point out glaring evasions of sanitary regulations in drainage of English dwellings, illustrating defects by engravings which fully justify the term "slipshod" adopted in the title of the paper, and would seem to justify even a stronger term, had the author wished to be sensational in his treatment of the subject. A large number of examples are thus treated. One only will be mentioned in this review,—a school in which the soil pipe "was connected without a trap to an offensive rubble sewer," and the whole of the drainage work was so defective that the soil for some distance around them was impregnated with foul discharges. Rain water pipes were directly connected with this drain, and four of them had openings just below and about six inches from where the school windows were opened to admit fresh air, no special means of ventilation having been provided.

Specification Writing.

In a series of articles printed in the *American Architect* entitled "Specification Writing," the whole being a lecture on this important subject delivered before the Architectural Department of the University of Pennsylvania, by Mr. T. Roney Williamson, architect, the following maxim relating to architects' specifications, which, indeed, applies equally to all specification writing, is given.

"Make your paths straight so that the wayfaring man though a fool, shall not err therein, but make them narrow as well, so that he shall have no room to wabble."

This series of articles is indexed appropriately in our department of architecture; but in the second number of the series there is a scheme for plumbers' specifications which may be of use to plumbers not only in preparing specifications for themselves, as they sometimes do, but also as expressing the views of an accomplished professional architect as to what a complete specification for plumbing ought to comprise.

A PAPER on "Diseases Occasioned by Emanations from Sewer Drains, Cesspools, and other Organic Refuse," written by Dr. Mark Jackson, of Barnstaple, England, and read at the meeting of the sanitary inspectors of that town, is well worth the perusal of all who, either as members of health-boards or as sanitary inspectors, or as general readers desire information upon the subject. The remarks upon what Sir John Simon many years ago styled "preventible diseases," to which Dr. Jackson attributes one-quarter of all the mortality in England, is of especial interest. The paper is printed in full, in *The Sanitary Record* (Sept. 8).

With regard to pyœmia and erysipelas, it must suffice to say that various outbreaks have been recorded, in which defects, of the kind already related, were found to exist, and on being remedied the illness ceased to occur. One other group of cases I should like to mention, viz., those affecting some of the internal organs, as the lungs, the kidneys, and possibly the brain. In 1888 Sir George Johnson published a series of cases of kidney affection, which he believed to be due to the absorption of sewer poisons after carefully excluding all other causes. The most appropriate case from my point of view is the following: A town surveyor, aged forty-seven, had been ill for several months and was found to be suffering from kidney disease of a serious form. Asked how his illness began, he replied: "I have not been well since I got blood-poisoning, eighteen months ago. I was supeinrtending the opening and repair of a blocked drain, and the smell was so bad, I came home and vomited several times. Next day I went again to open the drain, and the smell immediately made me vomit. At first I suffered from disordered digestion, with headache and vomiting. I have never been well since." And the poor fellow never recovered. Another case cited by Sir G. Johnson was that of a schoolmaster living in the basement of a schoolhouse, where there was a blocked drain, the area in consequence being flooded after heavy rainfall. He developed kidney disease, although a teetotaler.

Numerous other cases of disease resulting from sewer poison are cited. A private school, situated on the outskirts of a town of about 7000 inhabitants, had a lawn in front, separating it by about 25 yards from the public road. One of the main drains of the district passed beneath the road, and a ventilating opening had been recently made into the drain, in spite of a protest from the proprietor of the school. At the time the sewer was opened the wind blew towards the house, carrying with it a most offensive odor. A few days after the drain had been opened, about one dozen cases of illness, more or less serious occurred amongst the boys and other inmates, among which were cases of pleuro-pneumonia, complicated with abscess.

INDEX TO LEADING ARTICLES.

The ournals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

25030.—$1.50. Tests of Condensation in Cast Iron Radiators. William J. Baldwin (T C E–July.) 1500 w.

25056. Air Velocity—Anemometer Measurements. Editorial (Met W–Sept. 15.) 1000 w.

25057. Heating Philadelphia County Prison. Ill. (Met W–Sept. 15.) 2500 w.

*25201. Some Points in Ventilation (J G L–Sept. 11.) 2500 w.

25221. Methods of Constructing Chimney Flues and Pipes at Paris. Ill. Arthur Vye Parminter (Sc A S–Sept. 22.) 1100 w.

25285. The Efficiency of Insensible Ventilation. James M. White (A A–Sept. 22.) 2600 w.

25293. Heating and Ventilation of the Royal Victoria Hospital at Montreal. Ill. (E R–Sept. 22.) 1400 w.

25581. Remodeled Heating Plant in a City Residence. Ill. (E R–Sept. 29.) 700 w.

Landscape Gardening.

24988. Irrigation in City Parks (G & F–Sept. 12.) 900 w.

25700. Landscape Art and Rural Architecture. William Webster (L A–Sept.) 1100 w.

25702. Lawn Decoration (L A–Sept.) 500 w.

Plumbing and Gas Fitting.

*25007. Petroleum or Gas for the People? Editorial (J G L–Sept. 4.) 1600 w.

*25026. Slipshod Sanitation. Ill. W. L. Hunter (Pl D–Sept.) 2200 w.

*25136. Sanitary Plumbing. F. B. Brady (A L–Sept. 7.) 3500 w.

25210. Lessons in Practical Plumbing—Altering Underflow Work. Ill. Grayson (S P–Sept. 15.) 1300 w.

25289. Gas Piping for Buildings (E R–Sept. 22.) 900 w.

25295. Essential Requirements for the Gas Piping of Buildings (E R–Sept. 22.) 700 w.

*25345. The Sanitary Association of Scotland (S R–Sept. 15.) 2000 w.

Miscellany.

*25118. Diseases Occasioned by Emanations from Sewer Drains, Cesspools, and Other Organic Refuse. Mark Jackson (S R–Sept. 8.) 3800 w.

*25239. Cesspools for Country Residences. Ill. E. S. Marsh (D E–Sept.) 1100 w.

25247. The Greenhouse (Met W–Sept. 22.) 800 w.

Serials.

24542. Plumbing in Mr. C. P. Huntington's Residence. Ill. (E R–Began Aug. 25—4 parts to date—15 cts. each).

24643. Protection from Lightning. Alex. McAdie (E E N Y–Began Aug. 29—4 parts to date—15 cts. each).

25500. The Gas Cook Stove as It Is and as It Should Be. Adam Gasmann (P A–Began Oct. 1—1 part to date—15 cts).

25660. Congress of Hygiene at Budapest (A & B–Began Oct. 6—1 part to date—15 cts).

25716. Power and Heating Plant, Manhattan Life Insurance Building. Ill. (E R–Began Oct. 6—1 part to date—15 cts).

We supply copies of these articles. See introductory.

ELECTRICITY

The Truth About Municipal Electric Lighting.

If there is any one thing more than another respecting which it seems almost impossible to procure trustworthy data, it is the actual cost of operation in electric-lighting plants owned and managed by municipalities. Nowhere is it more true than in municipal bookkeeping, that although figures may never lie, liars are frequently permitted to figure. The *Electrical Engineer* has performed a real and lasting service to the public and to the profession, by giving in its issue of September 5, a series of carefully compiled tables exhibiting the results of a detailed and systematic inquiry into the workings of electric light plants in the United States under municipal management. This work has been done by Horatio A. Foster, a well-known expert in electrical industrial statistics, and may fairly be said to be a model investigation of its kind. More or less complete returns were received from 42 stations out of some 150 to which circulars of inquiry were sent. Of these, only 34 have given information admitting of complete tabulation. The inquiries relate to capital invested; cost of equipment; capacity of dynamos; operating expenses and fixed charges, with the necessary subdivisions of these general subjects. Fixed charges, *i. e.*, interest and depreciation, have been returned in but very few instances, and the deficiency has been supplied by the compiler from the best available data. In more than half of the 34 municipalities from which full reports have been received, the population is under 5000, rendering it extremely doubtful if a plant under any kind of management would be a profitable undertaking. All the items mentioned are worked out in the tables in great detail, but anything more than a brief summary of some of the most important deductions would exceed the space at disposal. The average cost of "full-arc" plants for city use is $249.30. This agrees very well with $250 per lamp, the price quoted formerly by a leading manufacturing company, and does not appear to sustain the contention that municipal plants are always more costly in the first instance than private ones. The cost of incandescent plants averages $258.91 per kilowatt, which does not seem to be excessive. A comparison of the unit cost per arc-lamp-hour in 14 municipal plants with the cost of the same in private plants, in cities of corresponding population as given in the census report of electrical industries in the state of New York, shows that the former is $0.0444, and the latter $0.0358, an economical difference of 20 per cent. in favor of the service supplied by private companies. One table given enables a comparison to be made between the total cost per kilowatt for the output of the station; the cost per kilowatt for city lighting after deducting the total income from the total gross cost, and the price per kilowatt to cities supplied by private companies. This table shows that the actual cost of electrical energy per kilowatt to a municipality, is greater when commercial lighting is furnished than when the city does its own lighting only, a fact which would seem to be explicable only upon the hypothesis of extremely low prices for commercial lighting. Mr. Foster has apparently taken the utmost pains to present the whole matter with perfect impartiality, and his results, so far as they go, may be regarded as more trustworthy by far than any figures heretofore given to the public. By way of a side-light on the question, it would be a pity not to quote part of a reply received from the manager of one municipal plant, which extract is herewith submitted without comment:

"The mayor and all councilmen, city clerk and all citizens of the city try to run the plant. The waterworks and electric lights are run together. As the mayor and committee with the assistance of a leather-headed clerk all dictate what shall be done and where supplies shall be bought, I therefore have no report to make. With eight years experience, I would advise all towns to hire their lights which is by far the cheapest. After May 1st the plant may be more in a business way. I am not in favor of any town or city owning an electric-light plant."

It may fairly be contended that Mr. Foster's figures do not support the assertions so confidently made in many quarters as to the superior excellence and cheapness of the service furnished by municipally-owned plants. Still, it must be said, that while the municipal figures might be much better, the figures of many of the privately owned plants are no better than they ought to be. There is evidently a great opportunity for reform in the bookkeeping of American electric lighting stations, both public and private.

Driving Factories by Electricity.

George A. Goodwin, president of the Society of Engineers, London, writing to the *Textile Recorder* of Manchester, makes some interesting observations in respect to the economy of electrically-driven machinery in factories, which are in part reproduced in the *Boston Journal of Commerce* (September 8). Mr. Goodwin points out that one inherent advantage in driving by electricity is that the conductors convey the power practically without loss and only in strict proportion to the demand, while in case of mechanical transmission the loss by friction is not only very considerable, but is a constant quantity, whether full or partial work is being done, amounting in many cases to as much as 20 to 40 per cent. of the gross power. The longer the distance of transmission and the less the load, the greater the proportionate loss; in many cases a very important matter. From the necessarily intermittent character of the work in factories and workshops, frequently only a small fraction of the work done by the engines is actually converted into useful effect at the machines. A further objection to the mechanical system is the almost insurmountable difficulty of economical extension; for instance, to increase a plant of 500 horse power to 700 or 800 horse power would require the almost complete substitution of heavier shafting, and a great augmentation of dead load on the structure, while in case of an electric installation, little or no radical alteration would generally be required. In factories where the machinery works intermittently and is liable to great fluctuations of load, the economy of working by electric power is very marked, as only a sufficient amount of current is required at any time to do the the work in hand. The current can be switched off and on with the greatest ease and rapidity, and in comparison, the use of cross-belts and loose pulleys appears to be a clumsy, not to say unscientific, method of handling power. Where each machine may have its own motor, a unique and highly economical method of using power is available. It is hardly necessary to remark that no hard and fast law can be laid down; each case must be individually considered, and that system adopted which promises the best results. In the case of existing works, it is probable that the cost of conversion to the electric system would seldom be warranted, but for new factories or renovations, without doubt the question of electric driving should be most seriously considered. In these days of fierce competition, when profits are reduced to their lowest ebb, the careful study of every possible means of economical working is of vital importance to every manufacturer.

The Earth as an Electrical Conductor.

The discovery that it was practicable to make use of the earth as a return conductor for telegraphic currents was made by Steinheil as early as 1837. In all practical telegraphic work, for half a century past, the earth has been regarded and treated as a conductor of infinitely small resistance, although in some special cases this assumption has proved to be very far from the truth. In attempting to use the earth as the return for an electric-motor line 3000 feet long, at the Alabama Polytechnic

Institute some two years ago, the terrene resistance was found to be abnormally great, and an investigation of the matter was accordingly undertaken by Mr. John H. Holt, the results of which are embodied in a serial paper in the *Electrical World* (September 22, 29). Two sets of earth plates were used; one pair of copper of 14 square feet surface, packed in iron filings and charcoal and buried in moist earth, and the other pair of iron, 2½ by 3½ feet, immersed in the water of wells dug for the purpose. With a dynamo current, the resistance of the earth was found to increase with the strength of current, and it was also found that the resistance was much higher when the plates were immersed in water than when buried in the earth. In another experiment, using intermediate plates, it was found that the resistance of the first 500 feet was greater than that of the whole 3000. This paradoxical result proved to be due to the character of the geological formation, which was Laurentian overlaid with drift. The resistance of the drift proved to be very much higher than that of the older formation. The effects of polarization were very marked in some of the experiments. Eliminating these, the resistance of the earth between the terminal plates was found to be 92.4 ohms, and between the plates immersed in the wells 121 ohms; much more than would have been expected *a priori.*

How Incandescent Lamps Are Made.

AT the end of the year 1893, according to the most trustworthy statistics accessible, there were in use in the United States, in central-station plants, a total of 2,500,000 incandescent lamps, and in isolated plants nearly 1,500,000 more, making a grand total of no less than 4,000,000 lamps. In view of these figures it certainly seems remarkable that so little information has been published respecting the processes and methods actually in use in the lamp factories of this country, and it is perhaps no less remarkable that one of the best papers which has yet appeared on the subject should be found in a journal devoted to a rival—we had almost said a hostile—industry. In the *American Gas Light Journal* (September 24) William E. McKay gives a minute and well-illustrated description, covering nearly four large pages, of the processes employed, presumably in the Beacon company's Boston factory, of making incandescent lamps with silk filaments. The substance of this description, if not its very language, is confessedly borrowed from an address by Mr. E. E. Cary before the graduating class of the Massachusetts Institute of Technology last summer, but electrical engineers will probably be glad to get hold of it, even in this roundabout way. One peculiarity of the Beacon process is the peculiar mechanical pump used in the exhaustion of the bulbs, by means of which it is alleged that a better vacuum can be obtained in 20 minutes than in two hours by the mercury process employed in the Edison factory. The majority of the employés among the lamp-makers are women, and the average daily output of the factory is 30 lamps per person. The author contends that the silk filament, when properly treated, averages 25 per cent. longer life than the bamboo filament preferred by Edison.

How the Carbon Brush Came Into Use.

A LARGE volume of current when handled at a high potential with direct-current apparatus gives rise to one annoying phenomenon which came near to making a total wreck of the entire electric-railway system, as we now know it. That phenomenon was the intense and destructive spark which appeared at the metallic commutator brushes. In the substitution for metal, of that strange substance, carbon, which has so often come to the rescue of the baffled electrical inventor, an effectual remedy was found. In a note in the *Electrical Engineer* (October 3) Professor Elihu Thomson in his usual graceful manner, gives the credit of this important application to the pioneer electric railway inventor, the late Charles J. Van Depoele, not forgetting however to mention that a similar suggestion had been made by Professor George Forbes in a British patent five years earlier, which apparently bore no practical fruit.

Illuminating Efficiency of Arc-Light Carbons.

CENTRAL-STATION managers have long suspected that there must be a great difference in the light-giving capacity of different brands of arc-light carbons, but experimental data on the subject have heretofore been almost wholly wanting. In the *Electrical Engineer* (October 3) W. F. Stine reports the result of tests made in the laboratory of Armour Institute, in which several well-known commercial makes of carbons were compared, and a variation found between the average of different brands of from 18 to 36 per cent. Were it not for the fact that the great brilliancy of the arc renders the eye a poor photometer, such a wide variation as 30 per cent. would be commercially ruinous to any company undertaking to furnish lights to the public.

A Small But Profitable Electric Lighting Plant.

IT has long been admitted that one of the most difficult problems in the whole range of the electrical industries is that of getting a dividend from a small electric station. As an interesting contribution to the discussion of this question, the *Electrical Engineer* (September 26) publishes an illustrated description, by Franklin L. Pope, of a small central station operated by water-power which has been running for more than a year past in Peterborough, N. H., a rural manufacturing town of about 2500 inhabitants. The author clearly shows that the unusual success of this particular plant is due wholly to intelligent and skilfull engineering and construction and the careful adaptation of the general plan of the work, as well as the details, to the requirements of the particular situation. Perhaps the most striking fact about the whole affair is, that although the dynamo is situated at a distance of between three and four miles from the district which is lighted by it, the whole business, at both ends, is successfully managed and operated by a single man. There are many places in the New England and Middle states, where the conditions are certainly no less favorable than at Peterborough for the establishment of an electric lighting plant, and it would seem that the example here given might in many cases be followed with profit and advantage. In fact the owners and managers of larger plants might find many points of interest and value in Mr. Pope's graphic and minute description of this little plant. His figures show quite conclusively that it is possible to earn a dividend of some 14 per cent. on an investment estimated at $11,000.

Chips From a Storage Battery Workshop.

THE knowledge we now possess of the laws of life and of health has for the most part been derived from the dispensary, the hospital and the dissecting-room. The storage-battery has been, thus far, but little less of a scientific mystery than the human organization, and it looks as if a knowledge of its idiosyncrasies could only be gained by analogous means. In the *Electrical Engineer* (October 3) Mr. James K. Pumpelly gives a graphic and entertaining résumé of some of his observations and experiences in a hospital devoted to the repair and rehabilitation of diseased and worn-out storage battery plates, in which may be found the clue to more than one of those mysterious and calamitous failures which have so tried the patience and depleted the purse of every one who has ever had anything to do with that "mule of science"—the storage-battery. It is a timely and valuable paper.

Electrical Manufacturing in Canada.

ELECTRICITY is destined to do great things in the future for the Dominion of Canada, especially in the industrial development of its numerous and extensive water-powers. Few people are aware of the extent of the electrical manufacturing interests of Canada, and it is therefore with a feeling of surprise that one reads the interesting and profusely illustrated account of the works of the Canadian

General Electric Company at Peterboro, Ont., by T. C. Martin in the *Electrical Engineer* (September 19). This is one of the most extensive manufacturing concerns in the British colonies, and is by far the largest manufactory of electrical goods; indeed, so far as variety of product is concerned, it probably has but one rival, even in the mother country. Every conceivable article used in electric-lighting and electric-railway service, from dynamos and street-cars down to watch-work meters and incandescent lamps, is turned out in great quantities and of a grade of workmanship comparing favorably with that of any other establishment in the world.

The Power Line From Niagara to Buffalo.

THE route and manner of construction of the power-line which is to transmit a portion of the energy of Niagara to the city of Buffalo has been a matter of much anxious consideration among those interested in this great enterprise. We learn from the *Electrical Engineer* (October 3), that an overhead line is to be constructed in duplicate by two different routes, one of which comes from the plant on the Canadian and the other from the plant on the American side. The route is principally along a special right-of-way 30 feet wide, which has been secured through the farms on Grand Island in the Niagara river. The total distance from the power-house to the Buffalo city limits, as the line is now located is only 13.25 miles. Steel poles and porcelain insulators are to be used.

The 5000 Horse-Power Dynamos for Niagara.

THE secret of the details of the mammoth dynamos now in process of construction for the electrical distribution plant at Niagara has been very closely kept, but by some means not stated, the *Electrical Engineer* appears to have got hold of it, and publishes (September 26) a sectional drawing, with descriptive text and some of the principal dimensions of this electrical monster. It has a fixed armature and horizontally rotating field, which at a speed of 250 revolutions per minute, produces two alternating currents in quadrature, each of 775 amperes and 2250 volts. The alternations are at the rate of 50 per second. It closely resembles in many of its features the design exhibited by Professor George Forbes before the London Institute of Electrical Engineers about a year since, which excited so great an interest and so much adverse criticism in professional circles.

Home-Made Electrical Instruments.

THERE is no possible way in which the student can arrive at so thorough an understanding of any piece of mechanism as to construct, with his own hands, either the machine itself or a working model of it. For this reason, Mr. G. E. Dunton has conferred a real benefit upon the electrical student and amateur, by furnishing minute and explicit directions, with all needful illustrations, for constructing a serviceable form of ammeter and voltmeter for measuring the volume and potential of electric currents. Mr. Dunton's article will be found in the *Electrical World* (September 22 and October 6) and will enable any one having a reasonable amount of skill in that class of handiwork to construct efficient and handsome instruments.

The Toronto Municipal Plant.

REFERENCE was made in this department last month to proposals which had been invited by the city engineer of Toronto for the construction of an arc-lighting plant for that municipality. According to the *Electrical Engineer* (October 10), the lowest bid for a complete city plant was $253,007, on which, allowing interest at 4 per cent. and depreciation at 6 per cent., the annual fixed charges would be $25,300, and the cost of maintenance $75,295. For 1300 street lights, this would involve a cost to the city of $77.37 per light per year. The local electric lighting company determined to hold the business if possible, put in a bid of $72.82½ per light per year. This bid was accepted, and accordingly the local company will, for the present at least, continue to do the city lighting of Toronto. But contractors who have spent much time and labor in making estimates and preparing bids for the new plant will hardly be particularly gratified to find that the only use made of their elaborate figures is that of a club to knock down the prices of a local electric lighting company.

Lightning Protection for Electric Circuits.

THE Franklin Institute Committee on Science and Arts has awarded the John Scott medal to Alexander J. Wurts, of Pittsburgh, Pa., for his original improvements in apparatus for protecting electric circuits from the destructive effects of lightning discharges. The report of the committee is published in the *Journal of the Franklin Institute* (October). Mr. Wurts' device for the protection of alternating circuits consists of seven cylinders of metal, each one inch in diameter and three inches long, mounted vertically side by side, and separated from each other by spaces of one sixty-fourth of an inch each. The central cylinder is connected to the earth and the two outer ones to the outgoing and return wires of a high-tension alternating circuit. When an electrical discharge to the earth takes place, either from one side or from both sides simultaneously, it is found that the flash is instantaneous, and is not followed, as is ordinarily the case, by an arc, while the change in the strength of working current in the circuit is too small to be appreciable. After-examination of the cylinders shows a slight black pit or burn where the discharge has passed. Mr. Wurts' discovery is that this property of non-arcing is one which is confined to certain particular metals and combinations of metals. The most common of these are zinc and antimony. With these metals it is impossible to start and continue an arc, provided thee are separated by an air-gap of one sixty-fourth of an inch. Mr. Wurts has also devised a complete system for the more effectual protection of long high-potential circuits, which consists in placing at various points, impedance coils of low resistance. These points, according to Mr. Wurts, become points of reflection for the high-frequency surging, which he considers to be the essential characteristic of lightning discharges. Mr. Wurts' devices are cheaply manufactured, and are said to act very effectively in preventing damage by lightning, and this without interrupting the normal course of operations upon the circuits.

Over-Compounded Dynamos in Parallel.

THE cross-sections of the conductors in a multiple-arc system of electrical distribution are determined on the basis of a certain percentage of loss in the conductors at some particular load. The loss in the line increases from zero at no load to the designated percentage at full load. In order to maintain a constant pressure at the initial point of distribution, the dynamo is often over-compounded, so that the pressure at its terminals increases progressively with the increase of current. In a paper in the *Electrical Wortd* (October 13) Professor E. P. Roberts shows that when two or more dynamos are connected in parallel and each compounded in the usual manner for a definite line loss, the automatic regulation of voltage aimed at will only be attained in case all the dynamos are kept in circuit. If one or more be disconnected when the load is light, those remaining will over-compound, not for the current in the line, but for the current in their armatures. In case only one machine is left in circuit, and that heavily loaded, it is possible for a maximum increase in pressure to take place when the load is at its minimum, and in case the load is of incandescent lamps, such a result might be disastrous to them. The remedies suggested are, either a multiplicity of independent circuits, which means the abandonment of parallel working, or else the use of rheostats in the shunt circuit which would seem to entail considerable waste of energy. Editorially, the *World* suggests the employment, in such cases, of plain shunt dynamos. Perhaps there may be still other practical ways out of this difficulty.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated W=Words.

Lighting.

*24952. Domestic Electric Lighting Plants. Nelson W. Perry (E Mag–Nov.) 3000 w.

25079. Electricity at the Wild West Show. Ill. (E W–Sept. 15.) 1200 w.

*25129. The Incandescent Electric Lamp Problem. Sydney F. Walker (C G–Sept. 7.) 1800 w.

25199. The "Feeder and Main" Patent Declared Void.—Judge Acheson's Decision (E R N Y–Sept. 19.) 4500 w.

*25281. Some Points on the Electric Lighting of Interiors (I & I–Sept. 7.) 2000 w.

*25315. The Cost of Glow Lamp Lighting. Extract from Work of J. A. Fleming (El–Sept. 14.) 1600 w.

*25317. The Illuminating Power of Projectors. F. Nerz (El–Sept. 14.) 1800 w.

25333. Internal Wiring. E. J. Erskine (A & B–Sept. 22.) 2800 w.

25334. The Incandescent Electric Lamp. William E. McKay (A G L J–Sept. 24.) 2200 w.

25392. Electric Lighting by Water-Power at Peterborough, N. H. Ill. Franklin Leonard Pope (E E N Y–Sept. 26.) 3200 w.

*25484. The Candle-Power of Glow Lamps. J. A. Fleming (El–Sept. 21.) 900 w.

25576. The Fire Risks of Electricity. S. H. N. (A G L J–Oct. 1.) 2000 w.

25605. How Shall We Meet the Competition of the Welsbach Burner? Ed. M. Highlands (E E–Oct.) 600 w.

25608. Concealed Electric Wiring in Modern Structures. Ill. Charles G. Burton (E E–Oct.) 1600 w.

25615. The Influence of Arc Light Carbons in the Candle-Power. W. M. Stine (E E N Y–Oct. 3.) 450 w.

*25683. Governing Electric Light Engines. Editorial (Eng L–Sept. 28.) 1400 w.

*25741. Photometric Magnitudes and Units. André Blondel, with Editorial (El–Sept. 28.) 7000 w.

*25742. The Electricity Works at Ealing.—Novel Departure in Central Electric Light Station Practice. Ill. (E E L–Sept. 28.) 10000 w.

25756. The Possibility of Securing Better Regulation at Central Light and Power Stations by Means of Fly-Wheel Accumulators of Improved Construction. Ill. John Galt (C E N–Oct.) 6000 w.

Power.

*24970. Storage Batteries. Henry F. Joel (E E L–Aug. 31.) 2500 w.

24982. Driving Mills and Factories by Electricity.—Its Economy Discussed by an English Engineer (B J C–Sept. 8.) 1000 w.

25051. Approaching Trials of Electric Locomotives (R G–Sept. 14.) 1300 w.

25082. How to Make a Dynamo Excite Itself. Ill. George T. Hanchett (E W–Sept. 15.) 2800 w.

25237. Method of Operating Electric Motors. Ill. (Ir Age–Sept. 20) 2200 w.

25302. Electricity on Highways. Possibility of Electrical Traction on Ordinary Railroads Not Likely to Be Fulfilled (B J C–Sept. 22.) 900 w.

25421. The Best Proportions of Armature Diameter and Length in Dynamos and Motors. Ill. M. H. Johnson (E W–Sept. 22.) 600 w.

†25498. Motor Repairs. James F. Hobart (S R J–Oct.) 1500 w.

25619. On Multiple Series Control of Motors on Small Electric Railways (E N Y–Oct. 3.) 1100 w.

25657. Power Transmission at Niagara Falls. Ill. (W E–Oct. 6.) 5400 w.

25658. Alternating Current Motors. L. M. Pinolet (W E–Oct. 6.) 3500 w.

Telephony and Telegraphy.

24995. The Commercial "All-Submarine" Cable from New York City to Europe. Ill. (E E N Y–Sept. 12.) 1400 w.

25035.—$1.50. The Load Line in Telephone Exchanges. Ill. A. V. Abbott (T C E–July.) 3300 w.

*25103. Determining the Position of a Fault in a Submarine Cable Between the Repairing Ship and Shore Station, when the Conductor Is Not Broken, by the "Fall of Potential Test." Ill. J. Rymer Jones (E R L–Sept. 7.) 2300 w.

*25254. Telegraphy Up to Date. George J. Varney (L Mag–Oct.) 3200 w.

*25267. Submarine Telegraph Property (E–Sept. 14.) 1100 w.

*25354. On the Minimum Current Audible in the Telephone (E R L–Sept. 14.) 2500 w.

*25355. An Attempt at a Quantitative Theory of the Telephone. Lord Rayleigh (E R L–Sept. 14.) 1500 w.

25377. Telegraphic Reminiscences. Charles Selden (E R N Y–Sept. 26.) 1300 w.

25419. The First Direct New York Cable. Ill. (E W–Sept. 22.) 2800 w.

25426. Duplex Telephony. Ill. T. R. Rosebrugh. (E W–Sept. 29.) 1600 w.

25752. President Plum's Address to the Military Telegraphers (E R N Y–Oct. 10.) 3000 w.

25755. Cable Construction and Cable Faults. Ill. F. J. F. Schwartz (C E N–Oct.) 2000 w.

Miscellany.

24991. Duncan Meter for Alternating Currents. Ill. W. S. Resor (E R N Y–Sept. 12.) 900 w.

24993. Schroon Lake: The Summer Diversions of an Electrical Amateur. Ill. (E E N Y–Sept. 12.) 2400 w.

25011. The Recent Accidents Occasioned by High-Tension Currents. M. G. Claude (E N Y–Sept. 12.) 3000 w.

†25058. Alternating Currents and Fuses. Dugald C. Jackson and R. J. Ochsner, with Discussion (T A I E E–Aug. and Sept.) 3000 w.

†25059. A Study of the Residual Charges of Condensers and Their Dependence upon Temperature. Frederick Bedell and Carl Kinsley. (T A I E E–Aug. and Sept.) 3000 w.

25080. The Discharge of Magnetism. Ill. M. A. Agelasto (E W–Sept. 15.) 1800 w.

*25104. The Capacity and Constitution of Dielectrics. Rollo Appleyard (E R L–Sept. 7.) 1000 w.

*25110. Integrators, Harmonic Analyzers, and Integraphs. Ill. O. Henrici (El–Sept. 7.) 4000 w.

25192. A Phonographic Method for Recording the Alternate Current Curve. Ill. C. J. Rollefson (E N Y–Sept. 19.) 600 w.

25195. The Development of Electric Manufacturing in Canada. Ill. T. C. Martin (E E N Y–Sept. 19.) 4800 w.

*25316. The Rise of Current in Inductive Circuits. Ill. Alexander Russell (El–Sept. 14.) 1500 w.

25376. The Testing of Insulated Wires. Ill. R. Varley, Jr. (E R N Y–Sept. 26.) 800 w.

25425. Engineering Education and the State University. (Abstract) William S. Aldrich (E W–Sept. 22.) 1900 w.

*25459. The Velvo Carbon Battery (E R L–Sept. 21.) 1100 w.

*25481. Alternating Currents in a Divided Circuit. Ill. Alexander Russell (El–Sept. 21.) 1100 w.

†25554. Change of Period of Electrical Waves on Iron Wires. John Trowbridge (A J S–Oct.) 1500 w.

†25555. Wave Lengths of Electricity on Iron Wires. Charles E. St. John (A J S–Oct.) 4200 w.

25602. The Electric Canal-Tugboat. Ill. F. M. F. Cazin (E W–Oct. 6.) 3000 w.

25606. The Life of the Lead Storage Battery. J. K. Pumpelly (E E–Oct.) 900 w.

25607. Commutators. Charles Lake (E E–Oct.) 800 w.

25612. How the Carbon Brush Came Into Use. Elihu Thomson (E E N Y–Oct. 3.) 1100 w.

25616. Chips from a Storage Battery Workshop. James K. Pumpelly (E E N Y-Oct. 3.) 2200 w.

†25650. The Chloride Electrical Storage Battery. Ill. (Report of Committee) (J F I–Oct.) 1400 w.

†25651. Wurt's Lightning Arresters for the Protection of Electric Lighting and Power Circuits. (Report of Committee) (J F I-Oct.) 1000 w.

*25734. Notes on the Design of Large Alternators. Rankin Kennedy (E R L–Sept. 28.) 1600 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L–Began Sept. 9, 1892—Ended Sept. 7, 1894—40 parts—30 cts. each).

23866. Dynamo-Electric Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W–Began July 21—10 parts to date—15 cts. each).

24437. Elementary Theory of the Induction Alternating Motor. Rankin Kennedy (E R L–Began Aug. 10—2 parts to date—30 cts. each).

24508. Magnetic Leakage in Dynamo Electric Machinery. Ill. Alfred E. Wiener (E E N Y–Began Aug. 22—6 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Ill. Newton Harrison (E A–Began Aug. 25—6 parts to date—15 cts. each).

24826. The Rise of Electricity. J. Mount Bleyer (E R N Y–Began Sept. 5—Ended Sept. 12—2 parts—15 cts. each).

24884. Electricity in the Modern City. Thomas Commerford Martin (J F I–Began Sept.—Ended Oct.—2 parts—45 cts. each).

24942. The Potential and Current Curves of Different Types of Alternators, and Their Influence on the Candle-Power of Alternate-Current Arcs. Ill. G. Rössler and W. Wedding (El–Began Aug. 31—Ended Sept. 7—2 parts—30 ets. each).

24969. The Use of Accumulators with Motors. Ill. M. G. Darriens (E E L–Began Aug. 31—Ended Sept. 7—2 parts—30 cts. each).

25095. Postal Telegraphs. Ill. James Bell (E L–Began Sept. 7—4 parts to date—15 cts. each).

25105. Standard Units for Electrical Measurement (E R L–Began Sept. 7—1 part to date —30 cts).

25420. How to Make a Voltmeter and an Ammeter.—For Amateurs. G. E. Dunton (E W–Began Sept. 22—2 parts to date—15 cts. each).

25424. The Earth as an Electrical Conductor. John Henry Holt (E W–Began Sept. 22—2 parts to date—15 cts. each).

25461. A General Theory of the Glow Lamp. H. S. Weber (E E L–Began Sept. 21—1 part to date—30 cts).

25482. The Chemical Theory of Accumulators. E. J. Wade (El–Began Sept. 21—2 parts to date—30 cts. each).

25483. The Construction of Resistances. D. K. Morris (El–Began Sept. 21—2 parts to date —30 cts. each).

25743. The Board of Trade Standards and Standardizing Laboratory (E E L–Began Sept. 28—1 part to date—30 cts).

INDUSTRIAL CHEMISTRY

How Shall Young Men be Educated in Applied Chemistry?

THIS very timely question has recently been discussed at some length by Dr. Peter T. Austen in the *Pharmaceutical Era*, and his remarks are reprinted in the *Scientific American* supplement. Dr. Austen emphasizes the growing importance of the chemist in manufactures, engineering, metallurgy, agriculture and indeed in all branches of modern industry, his intimate relationship with all these arts, and the need of a broad and liberal education to give him the proper grounding for any one of the multifarious specialties and functions he may select for his life work or may be called upon to assume. Since the future of a chemical student is often so uncertain the author recognizes the impossibility, in a strict sense, of laying out a course of study that would perfectly fit a man for each and all of the wide range of specialties; and holds that the training is not intended to do more than to ground a student thoroughly in the principles and practice of the science in such a way and to such an extent that he may be able to take up any application he may choose and follow it up by independent study and experimentation. The author's experience is drawn upon to point out the nature of a course of study, as followed in our best technical schools, and improved to accomplish the desired end; and he remarks that in some respects somewhat different courses are called for in the United States than in Germany, one cause among others being the wide difference which exists between the preparatory school education of the two countries. He insists upon a thorough drill in English branches as a preliminary, and considers the ability to read German a great advantage to the chemist who would keep pace with the times, inasmuch as most of the chemical literature is in that language, while indeed most of the chemical progress is now in Germany. Dr. Austen's ideal of a general education including history, the elements of law, political economy, mathematics, metaphysics, logic, ethics and literature is probably unattainable by the average chemical student in these busy days. It might be summed up in a requirement that the student should have taken a full course in a first-class college before entering upon his technical training; but the time and expense required preclude this for the majority of young chemists.

Coming to the direct training, Dr. Austen thinks that in many institutions the instruction in chemistry is too much confined to analysis, and that the graduates, although good analysts, are handicapped when entering a manufacturing works, where the difficulties and the methods are altogether new. The course should begin in the laboratory, and with a thorough and elaborate drill in experimental chemistry. Personally conducted experiments in chemistry and physics alone can induce originality of thought and give a comprehensive grasp of these subjects. Simultaneously a lecture course, well illustrated by experiments and accompanied with continued quizzing on the lectures, should go on. After experimental chemistry is completed, the author recommends a course in blowpipe analysis, followed by qualitative and then by quantitative analysis; and that, toward the end of the instruction in the latter, instruction in the preparation of pure substances should be given. During the course a carefully considered set of lectures should be delivered on technical chemistry, and special attention should be devoted to the relationship between manufactures. The technical collection should be well stocked, and visits should be made to representative manufactories.

It is gratifying to note that Dr. Austen gives prominence to a course of instruction in what is now termed "chemical engineering," While admitting that this is a difficult subject to teach, he believes that there are great possibilities in it, and incidentally suggests that there is here an excellent opportunity for a good text book. In study the various operations of precipitation, solution, evaporation, stirring, heating and filtration and the various mechanical devices should be grouped, independently of particular substances treated, and rather by substances of allied properties to be considered and manipulated in comprehensive groups. This line of study embraces the steam plant, pumps, vacuum and pressure apparatus, etc.

After outlining the usual curriculum, with many suggested additions and some innovations in details, the author lays stress upon the desirability of a year's post-graduate course devoted to higher chemical study undisturbed by other work. It is needless to say that a student who has conscientiously gone through the elaborate course delineated by Dr. Austen (and of which it is impossible to give here an adequate summary), would be very thoroughly equipped for beginning general practice or, with some experience and specialization, for almost any one of the numerous branches into which the rapidly developing science and art of industrial chemistry have been subdivided. It is to be regretted that comparatively few can avail themselves of so complete a training; but the number is growing, and consequently also the number of competent practitioners, while the tendency is constantly toward better work.

Yorkshire College Industrial Classes.

The *Chemical Trade Journal* contains an abstract of a recent report on the industrial department of the Yorkshire College, England, giving special attention to the work done by the classes studying the dyeing and the leather industries. Interesting researches have been made in both branches. Reports have been made on the composition and coloring principle of various dye stuffs and the action of light on colors.

Experiments made upon the chrome tanning processes have pointed to the best methods of manufacture and proportions of materials, while good samples of various leathers thus tanned have been turned out. The chrome method has been found applicable to the manufacture of glazed kid, and especially suitable for glove leathers because of softness, toughness and resistance to damp; also for imitation chamois, which has the advantage over the genuine of being easily and permanently dyed in almost any shade, with other good qualities and cheapness; for laces, belts, etc.; and as a substitute for calf-kid, having great durability, though somewhat lacking in fineness of grain; for "patent" and enameled leathers, etc. The analysis of leathers, it is believed, is of much importance to manufacturers, who have scarcely realized how much information may be gained in this way as to the methods of producing a given leather. Other researches have been made on oils and stuffing greases, presenting difficulties in really scientific analyses. The trade is recognizing the value of reliable methods and is showing interest in the analysis of tanning materials. The report indicates that the industrial department of the college is being conducted on thoroughly practical lines, and is suggestive to similar institutions.

Electrolysis of Alkaline Chlorides.

An illustrated paper on the electrolysis of alkaline chlorides for the preparation of caustic and chlorine is communicated by Mr. H. Y. Castner to the *Engineering and Mining Journal*, the cuts showing the new plant of the Aluminum Company, Limited, at Oldbury, England. The difficulty with all processes for electrolyzing alkaline chlorides has been to prevent the recombination of the products dissociated; to which end either special porous diaphragms or impervious substances have been used to keep apart the resulting products, or a fused electrolyte has been used, or mercury has been employed as a cathode only, with water treatment to remove the sodium in the amalgam. The Castner process is designed (1) to prevent recombination and the formation of hypochlorites, which destroy the electrodes, render the solution unfit for continuous use and decrease electrical efficiency; (2) to effect a large decomposition per watt per cell; and (3) to obtain strong and pure solutions. The new process employs mercury (which is an old idea), but radically differs from former methods. Its essential features are continuity, the use of a moving body of mercury which completely separates the products of electrolysis, the sodium amalgam being decomposed electrically as rapidly as formed. The cells are in three compartments (the center for mercury, the outer trio for chloride solution), and are made to rock from side to side. An arrangement of pipes and vats allows continuous circulation of the chloride solution, which is regenerated by passing through "saturators," and the drawing off of the caustic and chlorine in a pure state. The details of the plant are quite ingenious, and great claims are made for the efficiency and economy of the process.

Industrial Uses of Cellulose Thio-carbonates.

THESE interesting substances and their recently discovered derivatives have found numerous practical applications which have been worked out by Mr. A. Little, who lately communicated his results to the chemical section of the Franklin institute, and the *Chemical Trade Journal* now publishes a résumé showing the stage thus far reached. While at first many difficulties were encountered, development is now going forward very rapidly; and at present the most promising applications are as a substitute for glue and ebonite and as thin films for artificial leather, floor tiles, etc. There are now six commercial forms available: the crude solution, dense cellulose in the mass, separate films and sheets, films and sheets on cloth backing, porous cellulose, and various admixtures of cellulose and foreign substances such as untreated fiber or mineral matter. The raw material of almost all products yet made is in the form known to paper makers as soda fiber made from poplar; but it has been pointed out that any other cheap or convenient form might be used.

A 1 per cent. solution serves for bill-posting, bookbinding and the manufacture of straw boards, and has been extensively used, while experiments in the use of a stronger solution as a substitute for glue in carpentry indicate success, with a large balance as to cost in favor of cellulose. A 10 per cent. solution is as heavy as can be worked to advantage, while a 5 per cent. solution is as viscous as a 50 per cent. hot solution of glue. For the permanent stiffening and sizing of cloth there appears to be a large field for the decolorized weak solution, as also for collars, cuffs and shirt fronts. It may also be used as a vehicle in pigment printing on cloth, the solution being previously mixed with the pigment. A very dilute solution of thiocarbonate with alum finds application in paper sizing. The dense cellulose, formed by allowing the solution to revert or decompose, separating as a jelly, may be hardened and worked in any direction, resembles ebonite in appearance, takes a high polish, and can be used as an insulating material, or for buttons, tool handles and other small articles. The films may be made as clear as glass, or may be readily colored. Very many applications for them have already been found, as for photographic films, glazing of binders' board, facing blotters, imitation vellum, etc. Films on cloth may be used for curtains, bookbinding, upholstery, interior decorations and floor covering. The porous cellulose is adapted for fancy printing, embossed hangings, boxes, signs, etc., and it is claimed that the structure of the sponge can be reproduced. The list of applications of the solution in admixture with various foreign ingredients, as wood pulp and other fibers, clays, etc., is a long one and is partially suggested in the foregoing enumeration of some tried or prospective uses. Mr. Little's account opens out a very inviting field for the new compounds.

Adulteration of Essential Oils.

FROM the United States consular reports the *American Analyst* derives some remarkable statements as to the extent to which adulteration of the essences of lemon, orange, etc., is practiced in Sicily, and especially with regard to the essential oils prepared for export. French turpentine is the chief adulterant, and attempts have been made in the Italian chamber of deputies to places an almost prohibitory duty upon this substance, in behalf of the fruit producers, who are interested quite as much as the foreign consumers of the sophisticated products, The consul at Messina, who has been investigating the matter closely believes that adulteration can be stopped by several methods, the best one of which appears to be a refusal to buy except upon chemical analysis, with certified copies of the report. This course is not much favored by importers, however, although it is a safe one and comparatively inexpensive, analyses of large invoices of the same quality costing no more than on small lots. The polarimeter, now the principal reliance, is declared to be useless for tests, since the manufacturer can produce adulterated essences, having the same optical rotation as pure goods, by judiciously proportioning his ingredients. The instrument may be of great value to the honest manufacturer in ascertaining the optical rotation of his own product; but there its usefulness ceases. To test the accuracy of chemical analysis, many series of prepared samples were submitted to local chemists, whose reports agreed with practical precision with the known composition of the samples. The consul is confident that importers can secure pure essences if they are willing to pay for them.

A COMPOUND largely sold and used for preserving fruits and other perishable food, has been analyzed by Mr. H. A. Huston, who in the *American Analyst*, says it consists of sulphur (57.63 per cent.), cane sugar 14.20 per cent.) a little common salt as an accidental impurity, some nitrate of soda (1.36 per cent.), and 25.64 per cent. of charcoal, moisture and insoluble matter. The compound is burned in a closed space and the fumes absorbed by water; and the fruit, etc., should be exposed to the fumes and finally placed in the sulphurous water. The process is not approved.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

24955. Chemistry in the Foundry (E M J–Sept. 8.) 500 w.

24958. Recovery of Ammonia from Blast Furnace Gases (E M J–Sept. 8.) 1000 w.

24980. Peat Fuel in Germany (A M & I W–Sept. 7.) 1000 w.

25041. Tie and Timber Preserving Works at Las Vegas, N. M.; A. T. and S. F. Ry. Ill. F. Meredith Jones (E N–Sept. 13.) 1200 w.

*25092. Oxygen as a Cure for "Gassing." Editorial (C T J–Sept. 8.) 1200 w.

*25093. Industrial Classes at the Yorkshire College (C T J–Sept. 8.) 800 w.

25197. Adulteration of Essential Oils (A An–Sept. 15.) 2300 w.

25198. An Objectionable Food Preservative. H. A. Huston (A An–Sept. 15.) 500 w.

25224. Chemistry at the British Association (Sc A S–Sept. 22.) 1800 w.

*25310. Blast and Counter-Blast (C T J–Sept. 15.) 1600 w.

*25312. Industrial Uses of Cellulose Thiocarbonates (C T J–Sept. 15.) 1500 w.

*25320. Canaigre as a Substitute for Bark in Tanning (B T J–Sept.) 500 w.

25338. Electrolysis of Alkaline Chlorides for the Preparation of Caustic and Chlorine. Ill. H. Y. Castner (E M J–Sept. 22.) 2000 w.

25390. How Shall Young Men Be Educated in Applied Chemistry? Peter T. Austen (Sc A S–Sept. 29.) 6200 w.

†25522. Method for the Determination of the Freezing Point of Fatty Acids. F. Wolfbauer. Translated by S. S. Emery (J A C S–Oct.) 1500 w.

†25523. The Determination of Volatile and Insoluble Fatty Acids in Butter Fat. W. H. Beal (J A C S–Oct.) 900 w.

†25525. An Apparatus ("Lysimeter") for Determining Solubilities. Charles Rice (J A C S–Oct.) 700 w.

†25550. The Standardization of Potassium Permanganate in Iron Analysis. Charlotte F. Roberts (A J S–Oct.) 600 w.

†25656. Some Recent Contributions to Our Knowledge of Metallic Reducing Agents. H. F. Keller (J F I–Oct.) 3800 w.

*25705. The Chemical Pulp Process in the States (C T J–Sept. 29.) 1000 w.

*25706. Chemical Trade with Japan (C T J–Sept. 29.) 700 w.

Serials.

25094. Distillation. R. Tervet, Jr. (C T J–Began Sept. 8—2 parts to date—30 cts. each).

INDUSTRIAL SOCIOLOGY

A Trilogy.

THE *Forum* may be regarded as one of the best vehicles of thought published in America, particularly of that kind of thought which is fecundated and incubated in the libraries of professors in institutions of learning, and the study rooms of clergymen. In classing this as a kind of thought by itself no disparagement is intended. The thought of men devoted to study and learning has great value in dealing with fundamental principles of ethics, science and philosophy. In grappling with practical problems, it lacks something. A man may be perfectly competent to work out mathematically and in accordance with the laws of physics and mechanics all the principles involved in the construction of a proposed machine, and yet may be utterly incompetent to draw such practical plans and specifications for its construction as would enable skilled constructors to build even a working model, not to say one that would be satisfactory in its operation. Considering social organization, somewhat as we would a machine, that is to say, as something involving both theory and practice, knowledge of principles and skill in construction, it is not surprising that writers who possess singly the one or the other should, in dealing with professed social reforms, fail to work out practicable schemes. The magazine named has of late dealt with social questions very largely, and in its October number has printed three papers, the perusal of which has suggested what is here written. These articles, two of which are so interesting as to hardly admit of choice between them, are respectively entitled "Fundamental Beliefs in My Social Philosophy," by Prof. R. T. Ely; "Ely's Socialism and Socialistic Reform," by Prof. A. T. Hadley, and the "Contented Masses," by Octave Thanet, which is of a wholly different style. The two articles first named are, as literary productions, singularly felicitous in style, and embody much profound thought of the kind already alluded to. The title of Mr. Thanet's paper will be misleading to most readers, who will expect from it a much broader discussion than they will find in the paper itself.

The "Contented Masses" of whom Mr. Thanet writes with a glowing pen, constitute the population of Scott county, Iowa, comprising 43,164 souls, all told (the average real estate mortgage debt is $72 per head), and containing within its happy borders the city of Davenport, a town of 30,000 inhabitants, and several villages. Estimating the population of the villages as 3000, there remain 10,164 people who presumably are the farmers ot Scott county. Mr. Thanet's paper deals principally with the farmers, so that the masses whose content he calls to public attention narrow down to rather a small percentage of the entire population of the United States. These people are exceptionally favored if we are to accept all that Mr. Thanet has to say about them. He tells us "there is no question that it (Scott Co.) is one of the wealthiest and most thriving of the counties" in Iowa. "It believes in honest money, in the moderate use of the good things of life (including wine, spirits and malt liquors), in the full payment of debts, and in the protection of individual rights and property." Each citizen has on the average three times as much property as he has debt. The county poor house is not crowded, and the recent hard times have not materially increased the number of its tenants. The people are more charitable than in most places. There are several homes for old women where snuff and patent medicines are supplied to inmates who desire them; and one old woman is permitted to enjoy her stump of a pipe in the seclusion of the cellar. All of which goes to show that content of the masses promotes kindness of heart. The onions raised in Scott county are noted far and wide for size and quality, and the strawberries would also be as widely known could they bear shipment as well as onions. Altogether, the snuff and the short pipe, the onions and the strawberries, including wine, spirits and malt liquors, impart a mild and genial fragrance to the air of Scott county which presumably helps toward the almost blissful content of its population. However, its roads are confessedly bad, and this renders farm life lonely and isolated in the season when the roads are at their worst; and Mr. Thanet admits that the farmer's compulsory "dependence upon the Lord in the matter of sun and rain mysteriously inclines a man to gloom." Yet in spite of forced dependence upon the Lord, and the bad roads, the Scott county farmer lives in great comfort; "his daughter has a piano, and his wife a silk gown."

A similar charming picture is painted of the provincial workman of Scott county, as he is found in the city of Davenport, and in the several villages mentioned. The walking delegate is at a discount in Davenport, and the villages manage to exist without him. Davenport we are told "is known in labor circles as 'the scab town.'" Mr. Thanet says "'Mr. Howells' traveler from Altruria, before he shakes the dust of our country from his feet, and goes away to weep over us, should go for a brief space to a western town. There he might find manufacturers who voluntarily advance wages, and workingmen who voluntarily work overtime." The traveler from Altruria, not up in his geography, is minded to ask whether or no Pullman and Chicago, in which it has been currently reported there were slight labor disturbances recently, are western towns?—and why does not everybody follow Horace Greeley's advice, and go west?

Of Prof. Ely's social philosophy no fairer summary can be presented than is given by Prof. Hadley in the same number of *The Forum*.

> 1. Political economy makes the individual an end, in and for himself; in other words it is a gospel of Mammon and glorification of selfishness.
>
> 2. Socialism substitutes collective aims for individual ones. It is the result of a moral reaction against the traditional political economy,—a reaction which is taking hold of the masses, and which they are inclined to carry to an extreme.
>
> 3. The only way to prevent matters from being carried to such an extreme is for the wealthy and intelligent classes to adopt a great many socialistic measures on their own account, before the control of our social machinery is taken out of their hands.

This gives in condensed form the substance of Prof. Ely's contentions; the arguments by which he seeks to support them must be read as a whole to appreciate them; limited quotation would only misrepresent them.

Prof. Hadley regards the first of the above propositions as a mistake. He asserts that "political economy does not regard the individual as an end in himself"; and that "it does not glorify the pursuit of wealth except so far as this pursuit serves the interests of society as a whole." He deprecates "the so-called moral reaction against the teachings of economics" and charges that it is "in fact not so much a moral as an emotional one." Yet he claims not "to undervalue the emotional element in dealing with economic matters as men of purely intellectual type are prone to do."

> Reasoning about human conduct is full of chances of error; and if the outcome of such reasoning is to leave a considerable number of human beings in hopeless misery, society is justified in demanding that every promise and every inference in the chain of reasoning be tested, and every rational experiment be made to see whether such a consequence is really inevitable. Instances have not been wanting when the conclusions of the economists have proved wrong, and the emotions of the critics have been warranted by the event. The factory legislation of England furnishes an historical example. The economists, as a rule, condemned this legislation as wrong in principle and likely to do harm; but the results showed that these economists had overlooked certain factors of importance with regard to public health and public morals which vitiated their conclusions and justified public opinion in disregarding them.

He thinks it "safe to say that the harm done by laws based on unemotional reasoning is but as a drop in the bucket compared with that which has been done by laws based on unreasoning emotion." This mistake of allowing emotion to influence thought and action unduly, Prof. Hadley criticises in Prof. Ely's philosophy; and his paper is chiefly directed to the refutation of the first of the three propositions which are thought to fairly represent this phase of economic discussion.

Railway Companies and Their Employes.

In this the third of a series of papers written by Mr. Ossian D. Ashley, President of the Wabash railroad, for the *Railway Age*, he comes out flat-footed in the advocacy of profit-sharing, after an interesting review of the present industrial situation. In this paper, as giving a fair example of Mr. Ashley's views, the following paragraphs are conspicuous:

> In Europe adjustment of relations between labor and capital is a more threatening factor of disturbance than in this country (United States), and in that part of the continent where monarchical governments are the most absolute, the struggle is likely to be attended by tumult and bloodshed, which, under popular government, can be avoided. This conclusion is based upon the idea that underlying this question between labor and capital in Europe and adding to its strength and virulence, runs the current of protest against the political as well as social inequality of the people. And thus, that portion of Europe which adheres to even a qualified absolutism in its form of government is the hotbed and nursery of the extremists who lead most offensively in the ranks of socialism under the names of anarchists, nihilists and communists. The solution of this great problem in Europe it is needless to discuss here; the end is not within sight of the present generation, and even if we conclude that governments by the people will eventually prevail, human foresight cannot fix the period of its accomplishment. This view of the status of socialism in Europe, as compared with its growth and existence in the United States, will not, perhaps, be shared by Europeans who look upon the surface of popular movements in this country and think they detect in them a condition of society dangerous to the stability of republican government; but this conclusion is not accepted by those who have carefully studied the subject on the spot, for reasons given in my last paper.

The true solution of the social problem presented in the extract at least in the United States Mr. Ashley thinks will be found in the system of profit-sharing, for the trial of which he strenuously argues. In order to afford "a practical illustration of the idea," he supposes an employer and employé to reason each with himself. The manufacturer says:

> "If I can secure greater intelligence, greater industry and greater skill, I can utilize these valuable services so as to add to the superiority of my fabrics and economize in their cost, and thus add to my profits, I can well afford to distribute annually a fair proportion of these profits to the working men who have enabled me to obtain this success. It is for my interest to encourage these people who are trying to make our enterprise a success, and I will do it with great pleasure. We have but one object in view, and that is to succeed, and in that success to which they contribute so much, they should participate."

On the other hand the employé says: "My employer is willing to give me some share of his profit beyond my wages, if he is successful; he believes that I have aided to the best of my ability to secure that success, and I propose to give him the benefit of my best exertions, hoping to aid in making his enterprise prosperous. We are all engaged in a work in the success of which we are all interested."

The author then asks: "If such relations can be established between employers and employed, and the conditions fairly carried out, would it not go far toward solving the social problem satisfactorily?" From which it will be seen that Mr. Ashley regards profit-sharing as a panacea, whose trial will demonstrate its value as a remedy for social ills. Under the assumption that "it would be fairly carried out," doubtless it would relieve many of the strains in the relations between employers and workmen; but the writer does not fortify this assumption by anything which to the reviewer seems to carry the weight of assurance. However, he proceeds very ably to deal with "the ways leading to a practical accomplishment of the plan," and not only this, but other parts of the discussion will command earnest attention, on the part of those who either advocate or oppose as impracticable the proposed system of profit-sharing. It is evident that Mr. Ashley has much broader and more practical views on this subject than many contemporaneous writers. He admits, that in the nature of the case, "movements directed toward the establishment of a system of profit-sharing must be for a time experimental, and he sees that to be successful, "the hope of something higher and better in life" as a "constant incentive to exertion," and some system of promotion must go hand in hand with profit-sharing which will render it acceptable to the employed. Among other important innovations, he advocates pensioning off disabled and superannuated employés, who have been faithful in their service, holding that employers as well as employed should contribute to a fund for this purpose.

This able series of papers emphasizes two facts which are becoming very conspicuous in the current literature of industrial sociology; namely, that some of the ablest thinkers on this class of subjects are not occupying professorial chairs in universities and colleges, and that some of the best contributions to the discussion are now appropriately appearing in the technical journals, rather than in the reviews and literary magazines, or in the daily newspapers.

The Conundrum of "Labor Day."

"WHAT is the meaning of Labor Day?" Thus asks Mr. E. C. Gardner in the *Springfield Republican*, and adds remarks that fully justify the pertinence of his query. Another writer signing himself (or herself) "A Pleased Reader" having replied to the question in rhyme, the first-named writer replies to "Pleased Reader" also in rhyme, which brings out a counter-reply from the latter once more couched in rhyme. The *American Architect* prints the whole together under the title above given. In opening the subject Mr. Gardner asks:

Can you tell me what in heaven's name is the meaning of our new national holiday and why should it be called "Labor" day? What is it intended to commemorate or celebrate, and how should it be observed? If I should advertise to-morrow for 50 "laborers" I should probably have the next morning from 50 to 500 applicants bringing their strong arms and possibly a shovel or a hod by way of tools. There would not be one among them who could shoe a horse, weld a piece of steel, hang a roll of paper, solder a joint, make a chair, a box, or window-frame, plane a board, lay a brick, act as a motorman or conductor on an electric car, and still less handle a locomotive. They would be "laborers" pure and simple, and the advertisement would be properly answered. If I wanted anything else I should have to advertise for something else, for farmers, mechanics, clerks, teachers, or whatever it might happen to be. Now, there is nothing in common, unskilled labor that we need to exalt and glorify, to celebrate with the timbrel and the harp, the fire-cracker and the lunch-basket. It is indispensable and honorable, of course, if well done, but its spirit and achievement are not a sufficient cause for a national thanksgiving.

If "labor" is not thus restricted, then every man, woman and child who works either from necessity, choice, sense of duty or greed of gain, is a laborer. Whether the work is done with the hands, or the head, the feet or the mouth, it is work, and whoever does it is a laborer. He or she may be a clerk, a hod-carrier, a teacher, mechanic, farmer, engineer, commercial traveler, banker, lawyer, or journalist, manufacturer, milliner, typewriter, philanthropist, explorer or inventor; each and all belong to the world's great army of "laborers," and while there may be intrinsic, as there certainly are many factitious reasons given for esteeming one kind of labor as more desirable and worthy of respect than another, there can be no difference in the degree of honor that is due to those who are willing to do their part in the world's work according to their opportunity and ability; and no degrees in the dishonor that rests upon those who are willing to shirk it. Any other ground than this is absolutely undemocratic, un-American and un-Christian. The situation is too simple to admit of argument.

The rhyming answer to this refers Mr. Gardner to the politicians for a reply.

"Who with a little shuffling and evasion
Will show the need of labor recognition."

In the replication, Mr. Gardner winds up a humorous poem of three stanzas with the following problem:

Please tell me in these active days of "pull" and
"hustle,"

And tell me just as plain and clearly as you
can,
In what proportions of clear brain and healthy
muscle,
You would compound a genuine laboring man?
Inform me, and with me the many million
masses
Just where the line 'twixt "laborers" and "non-
laborers" passes.

ENVOY.

If all of us are "laborers" since creation was
begun,
Then in the words of Tiny Tim--God bless us,
every one.

To which in a poem of eight stanzas "Pleased Reader" makes a rejoinder, struggling in the fourth stanza rather desperately to solve the conundrum propounded by Mr. Gardner.

The laborer—in the popular dictionary—
Is one, it seems to me—hum—one who labors—
Hum—labors for another, something chary
Of paying larger wages than his neighbors;
Not, on the whole, a pampered proletary,
Who thinks he merits timbrellings and tabors
(I need that word in abors) and is wary
Of us who, being buoyed in the swim,
Seem to his ear, to condescend to him.

There is reason as well as rhyme in this playful debate, which may set some people thinking, who do not as a rule do as much thinking as is profitable in these perplexing times.

A Lesson in Industrial Economy.

PEOPLE of fair education, says the *Journal of Gas Lighting* (London) editorially, are in the habit of thinking that the foundations of the science of political economy "were laid by Adam Smith, and that the structure has been solidly built, in a plain but useful style of architecture by Ricardo, Bentham, Mill, and a host of other thinkers down to Prof. Marshall." Yet the writer of the article quoted finds, nevertheless, that public men at the present time are wont "to say and do things calculated to raise doubts as to the truth and utility of what have been taught as the fundamental data of this particular science."

In other words, instances daily occur in which, and a personage to whom prominent politicians to quote the immortal Captain Cuttle, the bearings of the observations of the political economists should lie in the applications thereof—and these applications are never made. Indeed, most of what is interesting and living in the industrial developments of the times, appears to spring up and struggle on without the slightest reference to the precepts of the science which is supposed to treat of the springs of action of mankind, as traders and producers. We see this illustrated by our Trade Union Congresses, Independent Labor parties and other manifestations of the working of the Time Spirit among the poorer classes in the community. If there is a science of political economy, there ought not to be a John Burns, or a Tom Mann, or a Keir Hardie. Yet these representatives of revolt against the established system of industrial society are in high feather, and take delight and find profit in saying things in the ears of the people of a nature to drive an orthodox political economist "howling to his gods."

The writer while deprecating the effect of attempts of "blind men to lead the blind through the mazes of the densest problems ever presented to painfully striving humanity," argues that all efforts to educate men of the agitator class spoken of as "Tom Mann," etc., are vain.

The mischief is that common workmen will not join classes for the study of political economy, even if the cultured professors of this science of the study and the arm-chair would care to have them for pupils. They will not of deliberate intent study anything, or read anything but newspaper reports of murders, bigamies, and sporting events. There are moments, however, when these men have nothing to do, nothing to think about, and nothing to say; and these idle times are the agitator's opportunity, of which he is not usually slow to avail himself. Not many years ago, the peripatetic socialists who went in for this class of business used to hold forth wherever they found a handful of loafers, and send round the hat when they had done speaking. This crude proceeding had the invariable effect of dispersing the assembly; and the poor orator was left comfortless. At last, a happy idea occurred to some of the astutest of the talking fraternity—they called themselves Trade Union leaders, and sold cards of membership instead of begging for coppers. The plan worked like a charm; and the out-at-elbow socialist of the last decade is now, if he knows how to keep decently straight, a member of parliament, an alderman, usually deem it advisable to be civil—but he has learned no political economy the while.

The specimen passages quoted would seem to indicate the article to be a virulent attack specially directed toward labor leaders as ignoramusus in all that pertains to economics and as agitators for mere mercenary ends, rather than for the advancement of the crafts they represent. But this would be to misconceive the motive of the writer, who holds that "the employer is often just as bad—worse, indeed, inasmuch as he ought to know better. Ask him how it is that trade is bad, or how it is that his particular trade is getting away from him and into other hands, and the chances are greatly in favor of his uttering in reply as many and as grievous economic fallacies as can be found in an average socialistic oration."

The article is really (though at first it might appear differently) an able argument against the position assumed by members of the Iron and Steel Institute, after having visited Belgium (the Belgian competition in the steel and iron trades being generally "a very sore point with English traders"), that the Belgians are beating them because the latter work long hours for little pay. Against this fallacy the writer of the editorial under review sets the full force of a weighty pen,—mighty because he who uses it to express his thoughts has real thoughts to express. He sees that "behind the question of wages rates lies, for the employer, that of the cost of labor; and for the workman, that of the commodities he can obtain for his week's pay." He holds that "both employers and employed are apt to look too exclusively at the mere wages rate, which is against all economic teaching, and is distinctly reactionary." He regards the movement in the direction of profit sharing as by no means a panacea, "but rather as a concession to the humane sentiment which seeks in the modern industrial world some such interest in his employment as the journeyman of old possessed in the hope of becoming a master in his turn."

We are told that in Belgium all employés are given an interest, not in the profits, but in their position, "They get more than money." When one proceeds to inquire what this additional something is, it is found to consist of cheap lodging—provided by the employer; free schools—also provided by the employer; and cheap flour and other necessaries, supplied at about cost price from the employer's stores. These advantages are supposed to satisfy "Les braves Belges," and keep them from striking like their English fellows. If this is so, the Belgian workman must be a very easily satisfied man; for part payment by "truck," whether to the employer's profit or not, never yet made an English or an American workman contented.

The situation is viewed hopefully, however. The lesson which a workman needs to learn is how to save for himself, instead of, as in profit sharing, "trusting to his employer to save for him. As the day of the small master is passing away," the author hopes that "the day of the small investor is dawning."

Stokers and Pokers.

Two kinds of labor the details of which are not very familiar to the public, yet which are generally believed to be extremely exacting and exhausting, are what are known in the gas industry as "poking" (a new term defined below) and stoking. Those who are in search of material relating to the labor employed in various occupations will do well to read what is said upon this subject in the *Journal of Gas Lighting* under the above title, in an article of more than ordinary interest contributed by Mr. Thomas Newbigging. He divides the employés of gas works into four classes, viz.: (1) skilled workmen, (2) stokers, (3) laborers, (4) the official class, such as engineers and managers, secretaries, chemists, clerks, foremen, storekeepers, meter inspectors, and collectors. Stokers are considered as laborers, and there is still another class which he styles "pokers"—"philanthropical and emotional pokers" of their noses into other people's business. It is presumably these pokers who are considered by Mr. Newbigging as creating a good deal of misplaced sympathy for the stokers, whose work as described in the article appears not to be more severe than most laborers' work. The interest of the article is well sustained from beginning to end.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

24971. The Planters' Meeting at the Hotel Royal (L P–Sept. 8.) 7500 w.

24972. The Donaldsonville Meeting of Sugar Planters (L P–Sept. 8.) 4200 w.

24979. Workmen's Houses Tenure (R R–Sept. 8.) 800 w.

*25008. Stokers and Pokers. Thomas Newbigging (J G L–Sept. 4.) 2500 w.

25064.—$1. The Ultimate Standard of Value. E. von Böhm-Bowerk (An A A–Sept.) 21500 w.

25065.—$1. Relation of Labor Organizations to the American Boy and to Trade Instruction. E. W. Bemis (An A A–Sept.) 10800 w.

25066.—$1. The Beginning of Utility. Simon N. Patten (An A A–Sept.) 1800 w.

25067.—$1. Present Condition of Sociology in the United States. Ira W. Howerth (An A A–Sept.) 4000 w.

25068.—75 cts. Are We Awakened? H. von Holst (J P E–Sept.) 13300 w.

25069.—75 cts. Gold and Silver in Santo Domingo. J. Lawrence Lougblin (J P E–Sept.) 9800 w.

25070.—75 cts. The Formula of Sacrifice. H. J. Davenport (J P E–Sept.) 5200 w.

†25087. The Gold Question. An Appeal to Monometallists (N C–Sept.) 6000 w.

†25089. Britain and the United States.—Cost of Living Compared. Andrew Carnegie (C R–Sept.) 4000 w.

†25091. "If Christ Came to Chicago." Goldwin Smith (C R–Sept.) 4600 w.

*25125. The Industrial Competition of Nations. Editorial (E–Sept. 7.) 2800 w.

*25133. Labor and Wages in Belgium. Editorial (Eng L–Sept. 7.) 2500 w.

†25142. Philosophy and Industrial Life. J. Clark Murray (Mo–July.) 5600 w.

†25143. Co-operation and the Agricultural Depression. Edmund Mitchell (W R–Sept.) 3000 w.

25172. The Tennessee State Convict Mine. L. E. Bryant (E M J–Sept. 15.) 1000 w.

25216. State Ownership and Protection of Forests (E N–Sept. 20.) 3500 w.

25236. The Tariff and Our Coal Trade (S V–Sept. 15.) 2000 w.

25248. A Labor Day Talk.—Address of Joseph R. Buchanan (J M W A–Sept. 22.) 3800 w.

†25256. Some Anarchist Portraits. Charles Malato (F R–Sept.) 9000 w.

†25258. Imaginative Currency Statistics. J. Barr Robertson (F R–Sept.) 6300 w.

*25265. The Trades Union Congress, 1894. Editorial (E–Sept. 14.) 2200 w.

*25276. Profit-Sharing in the Coal and Iron Trades. D. F. Schloss (C G–Sept. 14.) 6300 w.

25287. The Conundrum of Labor Day. E. C. Gardner (A A–Sept. 22.) 1000 w.

*25314. The Miners Strike in Scotland and Sliding Scales (I C T–Sept. 14.) 2200 w.

*25321. German Commercial Unions (B T J–Sept.) 1800 w.

*25322. Establishment of an Official Department of Labor in Spain (B T J–Sept.) 650 w.

*25328. The Economic Condition of Japan (J S A–Sept. 14.) 1700 w.

25331. Rights of Land Owners. Editorial. (A & B–Sept. 22.) 1200 w.

25335. Bimetallism vs. Silver Monometallism. R. P. Rothwell (E M J–Sept. 22.) 3000 w.

25370. Harmony vs. Monopoly (B D–Sept. 22.) 700 w.

*25396. Fundamental Beliefs in My Social Philosophy. R. T. Ely (F–Oct.) 5000 w.

*25397. Ely's "Socialism and Social Reform." A. T. Hadley (F–Oct.) 3000 w.

*25398. The Contented Masses. Octave Thanet (F–Oct.) 6000 w.

†25402. The Municipal Problems of London. George Robert Tyler (N A R–Oct.) 3500 w.

*25429. A Lesson in Industrial Economy (J G L–Sept. 18.) 2000 w.

*25447. British Railway Traffic and Strikes. Editorial (E–Sept. 21.) 2500 w.

*25450. The Scotch Coal Strike. Editorial (Eng L–Sept. 21.) 1500 w.

25465. Labor in Non-Union Mills. Editorial (A M & I W–Sept. 28.) 700 w.

*25491. Declaration of the Bimetallist Members of the German Silver Commission. Translated by E. Benjamin Andrews (R of R–Sept.) 4500 w.

†25495. The Youngstown Street Railway Strike (S R J–Oct.) 1600 w.

†25496. Taxation. Allen Ripley Foote (S R J–Oct.) 4400 w.

25507. The Depression and the Employment of Labor. George M. Steele (B C–Sept. 29.) 700 w.

25511. Lessons of the Strike. G. W. Rhodes (R R–Sept. 29.) 2000 w.

*25520. Scientific Money. T. W. Graham (Mill–Sept.) 1700 w.

†25533. Is the Friction Between Employed and Employer Diminishing? Albert S. Bolles (C M-Oct.) 2800 w.

*25570. Profit Sharing in the Coal and Iron Industries. Editorial (I C T–Sept. 21.) 1600 w.

Serials.

24586. Railway Companies and Their Employés. Ossian D. Ashley (R A–Began Aug. 24—4 parts to date—15 cts. each).

MARINE ENGINEERING

Marine Mechanical Stoking.

MECHANICAL stoking has made considerable progress on land in stationary engine practice; but for locomotives and marine engines very little has been accomplished in this direction up to the present time. There are difficulties to be met in machine stoking for these classes of engines as contrasted with stationary which very much enhance the intricacy of the problem. Those who wish to gain some knowledge of these special difficulties, in so far as relates to marine boilers, will do well to read a series of articles entitled: "Is a Marine Mechanical Stoker Impracticable?" written by Mr. Sidney H. Holland, and commenced in the *Mechanical World* (London and Manchester), Sept. 7.

The writer starts out with the declaration that "the very greatest desideratum of the age, is, in all probability, a practicable mechanical stoker, or other firing apparatus adapted for marine purposes"; and any one familiar with the way coal is now passed from the coal bunkers and fed to the boiler furnaces on large steamships, will not be disposed to dispute either the declaration, or the pertinence of the query which this writer makes the title of his article.

Every large steamer carries quite a small army of skilled laborers, to be provided for in stores, accommodation, and pay, forming at least four-fifths of the entire steam staff, whose duty involves the most arduous toil imaginable, and whose working lives, are as a rule, thereby prematurely worn out and shortened. From a humanitarian point of view, the obviation of this present necessity would be an incalculable boon; and on commercial and financial grounds, an efficient automatic substitute for all this manual labor would seemingly be the greatest acquisition that the steamship owner and the marine engineer have yet known. It seems somewhat of an anomaly that having now developed all other accessories of the marine engine and boiler to such admirable comparative perfection, we should still be laboriously trudging along with hand-stoking. It is remarkable that nothing has yet been achieved in this direction, considering the great desirability of, and equally great demand for, such a machine when once produced in a practical and efficient form. Are there insuperable difficulties in the way of changing all this?

Pursuing the subject further the fact is noted that for stationary boilers, "several fairly good mechanical stokers, and at least two excellent ones have been produced," and these are meeting with merited approval and extending use. A gas stoker (West's) is also mentioned as being a fairly efficient machine, though the difficulties met with in the invention and construction of such a machine appear to Mr. Holland as at least equal to those attending the construction of a marine stoker.

In reporting the results of a competitive trial of machine stokers last year, Mr. E. Ingham, consulting engineer, of Oldham, said: "There is no question whatever in my mind that hand-firing is doomed to give place to some form of automatic machine-firing in the immediate future." There really seems but little doubt that we must eventually come to mechanical marine stoking, or automatic firing in another form.

The author then proceeds to discuss three possible lines in which mechanical stoking for marine purposes may be developed; to wit, "a development of the best existing forms of land machine stokers using coal, the use of hydrocarbon liquid fuel, and the use of gas fuel." He then passes in review the various forms of land machine stokers, and competitive trials of these machines, concluding this first number of the series with an enumeration of the advantages of machine stoking in general, as compared with hand labor stoking.

With no desire to undervalue the importance of the subject of which the first paper of this series gives good promise that it will be ably treated, it seems to the reviewer that the revolution now in progress with marine boilers is likely to replace boilers hitherto used by water-tube boilers, and this may so change the conditions of the problem in a few years that premature effort directed towards the evolution of marine mechanical stokers is likely to be wasted. However, this remark may, perhaps, anticipate what the author of the series intends to say in future numbers of the series.

Trials of Dynamite.

THE first attempts to throw shells charged with high explosives from guns, through the agency of air compressed to from 800 to 1000 pounds to the square inch, and upward, were made in 1886 under the auspices of the U. S, Navy Department. The first pneumatic gun made for the purpose was built at the Delamater Iron Works in New York city, The measure of success attending experiments with the first gun made, indicated possibilities which encouraged further experiment, and efforts toward improvement have been constantly put forth since the time mentioned, and with gratifying results. *The Iron Age* has printed a résumé of the progress made thus far, beginning with the first government trial of the pneumatic system in 1889, and extending down to the recent trials with 8-inch and 15-inch pneumatic guns at Sandy Hook. The reports of the chief of ordnance have always been favorable to continued experiment with the system. The following paragraph quoted from one of the latest of these reports shows how the subject is regarded in the U. S. War Department.

> Each time the conclusion has been more or less favorable. Each report, however, has stated that the accuracy of the guns leaves much to be desired. It is manifest that the accuracy of a gun is its most important quality, and without a satisfactory degree of accuracy all other advantages are of minor importance. The difficulty in the pneumatic guns appears to center in the main valve which admits the air to the gun. At all ranges except the maximum the successful working of the gun demands that this valve should open and close in an exceedingly short time, probably a small fraction of a second. The difficulties encountered in accomplishing this have not been overcome. The department has already expended $30,000 upon experiments with these guns without any decided improvement. Without entering further, at this time, into the merits of the system, the bureau recommends that further experiments be deferred until after the installation at Sandy Hook of the 15-inch guns now in course of construction for the War Department. In these guns the company promise to overcome the difficulties which exist in those of the *Vesuvius*.

The article reviewed states that the recent trials have proved that the defects in the valve alluded to have been remedied. It adds that "the tests also proved that the guns could be rapidly handled and that the shot could be delivered with certainty at any point within range of the gun." These results show that an important addition has been made to the destructive appliances of modern warfare.

The terms of the contract made by the government with the Pneumatic Dynamite Gun Company demanded that the 8-inch gun must be able to cover all ranges from 100 to 2600 yards with a shell containing 100 pounds of explosive gelatine, and from 100 to 3200 yards with shells containing 50 pounds. The 15-inch gun, with 50 pounds, must range from 100 to 5500 yards; with 100 pounds, to 4500 yards; with 250 pounds to 3550 yards; with 500 pounds, to 3000 yards.

> The rapidity of loading and firing varies with the amount of the explosive in the shell, but the time must not exceed three minutes for one shell of 500 pounds, or forty minutes for ten consecutive rounds. For a shell charged with 200 pounds, two minutes are allowed, or 27 minutes for ten consecutive rounds. The rate of rapidity continues to increase with smaller charges, ten rounds in 20 minutes being reached. The 8-inch gun will be fired five rounds with 50 and five with 100 pounds in the shell, while the 15-inch will be fired three rounds with 50, eight with 100, ten with 200, and five with 500. The remaining gun of this caliber, if those tests are successful, will require only half a dozen proof rounds for testing its general working ability.

These tests for rapidity are said to have exceeded the requirements. The range can be changed without change of elevation in the gun, by "controlling the amount of compressed air that escapes at each discharge." The mechanism by which this is effected, the system whereby the reservoir is always kept stocked with compressed air, and the system of loading the gun, are all described in this very interesting article.

Past and Present Steamship Records.

In these days of record breaking both on the part of our great Atlantic liners and with our new cruisers, nearly everybody could find pleasant reading in an editorial résumé under the above title which is printed in the *American Shipbuilder* in its issue of September 13th. This is a running statement,—substantially chronological—of the records made from and including the first voyage of the *Britannia*, the first ship of the famous Cunard line, up to date. Interesting particulars of dimensions, kind of propelling wheel (paddle or screw), dates of first voyages of once famous ships, whose glory has since been eclipsed, etc., accompany the records of their speed. The following is abstracted from the article named.

The first Cunard steamer, the *Britannia*, achieved a speed, from 8¼ to 8½ knots an hour. The average duration of the Cunard voyages in the year 1856 was 12.67 days from Liverpool to New York, and 11.03 days from New York to Liverpool. The *Bothnia*, in 1874, reduced the passage to about 9 days. The White Star *Britannic*, in 1876, averaged 7 days, 18 hours, 26 minutes, outward from Queenstown to New York, and 9 days, 6 hours, 44 minutes on the eturn. The *City of Berlin*, of the Inman line, also built in 1874, made the westward voyage in days, 10 hours, 56 minutes, and eastward in days, 2 hours, 37 minutes. From the year 874 to 1879 no further advance was made in Atlantic steaming, but in the latter year the *Arizona* was added to the Guion line, and it oon became evident that another important tride had been made in the Atlantic passenger ade which would lead to most important results. he Guion line, which had started in 1866 with he *Manhattan*, had now the fastest passenger eamer on the Atlantic. In spite of burning me 50 per cent. more coal than the *Britannic*, he was an obvious commercial success. The irited policy which brought her into existence was appreciated by the public, and the other lines had to move forward. Then followed a period of rivalry, the Cunard Co. building the *Gallia* and *Servia*, the Inman line the *City of Rome*, and the Guion line the *Alaska*, all of which were completed in 1881, and afterward the *Oregon*, in 1883; the *Aurania* the same year, and later still the *America* for the National line, and the *Umbria* and *Etruria* for the Cunard Co. in 1885. From the 15 days' passage or thereabouts of the earliest Atlantic steamers we have got down to 5 days, 9 hours, 27 minutes.

A Serious State of Affairs.

The fact that there is not a single dry-dock in the United States large enough to dock the new battleships of which the nation (barring the doubts that have recently been cast upon the integrity of their armor plates) feels justly proud, is the theme of a good editorial in the *American Shipbuilder*. The sea is a treacherous element, and any of these ships might meet with accident in encountering its perils at any time. This would imperatively demand immediate repairs. That we do not possess facilities for making such repairs, and would have to seek foreign dry-dock accommodation in such an event is justly regarded by the paper quoted, as "a humiliating position for a great nation to be in."

The question arises why is it that there is so much delay in completing the Brooklyn Navy Yard Dry Dock, which is to be the largest in the world, and is the only one in this country, except those now under construction at Port Royal and Puget Sound, in which the new battleships can be cleaned? The Brooklyn dock was originally to be 600 feet long and to cost $412,000. Its length has lately been increased to 670 feet and price to $462,619.18.

It appears from this article that the contractor to whom the contract for constructiug this dry-dock was awarded, has been so dilatory in executing the work as to have been "repeatedly warned that the progress he was making was not satisfactory to the Government," and that he has been "permitted to continue the work under certain assurances which, it is said, have not been fulfilled." The article also states that the contractor has now been "notified to show cause why his contract for constructing the New York Navy Yard dock should not be cancelled."

The Navy Department is censured for preferring the bid of a contractor inexperienced in this kind of construction to that of an experienced company that makes a specialty of such work; the only apparent reason for such action being that the former offered to do the work for $125,000 less than the latter. The *American Shipbuilder* now insists that this was false economy, and asserts that the Government would have saved both time and money by giving out the contract to the company that made the higher bid, rather than to a contractor who had "never built a structure of that kind.

"Is the Government obliged to accept the bid of such a person in lieu of men of long experience in dock constructing, and who have made it a life study, simply on account of a difference of a few thousand dollars? If so it is time there was a change in the statutes."

This is followed by a history of the advertising for bids for the construction of timber dry docks at Brooklyn and Norfolk navy yards, and for dry docks at other points, the names of those who bid for the contracts, and the opening of the bids and awards, with facts relating to Government dry-docks now built and in operation, compiled from the Washington correspondence of the *Brooklyn Eagle*, all of which points clearly to the fact that previous awards of contracts of this kind to contractors inexperienced in such work have almost uniformly resulted in imperfect construction and loss to the Government.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25003. On a Rapid Method of Calculating Wetted Surfaces. Archibald Denny (M E–Sept.) 700 w.

*25004. Messrs. Blackwood and Gordon's Shipbuilding Yard, Port Glasgow. Ill. (M E–Sept.) 500 w.

25017. Trials of Dynamite (Ir Age–Sept. 13.) 1300 w.

25037. Past and Present Steamship Records (Am S–Sept. 13.) 700 w.

25043. The Design of Ferry Steamers. Ill. Abstracts of papers by Edwin A. Stevens, Andrew Brown and Charles Jones (E N–Sept. 13.) 6500 w.

*25101. The Progress of Steam Navigation (P Eng–Sept. 7.) 4400 w.

25211. The Elevator Barge Company.—System of Coaling Steam Craft by Patent Steam Power Elevators. Ill. (Am S–Sept. 20.) 250 w.

25231. The New American Liners (Sea–Sept. 20.) 2200 w.

25242. The Cramp Ship-Yard. Ill. Fred H. Colvin (M A–Sept.) 2000 w.

†25257. The Naval Manœuvres. Nauticus (F R–Sept.) 4600 w.

*25266. The Work and Cost of the Navy. Editorial (E–Sept. 14.) 2500 w.

*25269. The Decennial Programme for Naval Construction in France (Eng L–Sept. 14.) 4000 w.

*25270. The Decadence of Shipbuilding on the Mersey (Eng L–Sept. 14.) 2000 w.

*25309. British Mercantile Marine and Its Protection (Tr–Sept. 14.) 500 w.

*25451. The Vibration of Steamships. Editorial (Eng L–Sept. 21.) 2000 w.

*25458. The Decay and Failure of Tail Shafts in Steamers. Ill. (I & I–Sept. 21.) 1400 w.

25561. The United States Armored Cruiser "Maine." Ill. (Eng–Sept. 29.) 3600 w.

*25575. Quadruple-Expansion Engine for Third Class Torpedo-Boat. Ill. (A E R J–Oct.) 2000 w.

†25652. The Centrifugal Pumping Plant at Mare Island Navy Yard, California. Ill. John H. Cooper (J F I–Oct.) 2500 w.

25665. A Long Island Sound Palace—The City of Lowell. Ill. (Sea–Oct. 4.) 3000 w.

*25679. The Harbors and Ferry System of Denmark. Ill. A. E. Carey (E. Sept. 28.) 2500 w.

Serials.

16636. Marine Engine Design (M W–Began Oct. 6, 1893—14 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E–Began April 14—18 parts to date—45 cts. each).

24695. The Guns and their Mountings of Spanish Belted Cruisers. Ill. (E–Began Aug. 24—Ended Sept. 7—2 parts—30 cts. each).

24868. American Ships for American Commerce (Sea–Began Sept. 6—Ended Sept. 13—2 parts—15 cts. each).

25010. Is a Marine Mechanical Stoker Impracticable? Sidney H. Holland (M W–Began Sept. 7—Ended Sept. 14—2 parts—30 cts. each).

MECHANICAL ENGINEERING

Hardened Rollers as Pressure Bearings.

THE extended use of roller and ball bearings is one of the features of current mechanical progress. It is, however, entirely safe to say that many data yet remain to be added before our knowledge of this class of bearings will be complete. A contribution to further knowledge of the subject has been contributed to *American Machinist* (Sept. 27) by Mr. Oberlin Smith. In this article he explains that he was led to a closer study of roller bearings, by the contemplation of the construction of "a press for coining purposes with rolling toggles," for the designing of which he prepared himself "by investigating to some extent the available pressures attainable upon convex cylindrical surfaces of hardened steel, when rolling upon a plane, or upon other convex surfaces of the same material." As this excellent article contains many diagrams and tables, all that will be undertaken in reviewing it will be to impart an idea of the method pursued in the investigation, and this can best be done by quoting the author's description of it which follows. For the data of the respective experiments and tests the reader must consult the article itself, which occupies about four columns of the paper in which it appeared.

> I prepared several blocks of an ordinary quality of tool steel, hardened in water and tempered to a straw color, which I afterward had submitted to compression tests in the large United States testing machine at Watertown, made by Mr. Emery. The respective radii of these blocks were 1 inch (marked 1 A); 2 inches (marked 2 A); 3 inches (marked 3 A); 4 inches (marked 4 A) and 5 inches (marked 5 A). Their length, parallel to their axes, was approximately 1 inch; their width, at right angles to the same, 2 inches, and their height, in a radial direction, about 1 inch. There was another block (marked 4 B) whose length was a little over 2 inches. The length of the working face of these blocks which formed the line of contact upon the lower or anvil block was about ½ inch less than the figures above given, as the lower corners were beveled off at an angle of 45 degrees, the cross section of metal removed being, therefore, a right angled triangle with a base of about ½ inch.
>
> The anvil block upon which these were tested was of the same material and measured about 4 inches square by 1 inch thick.

The results of these tests as reported by Captain Varney, commandant of the Watertown Arsenal, are then given in tabulated form with diagrams, and may prove a valuable addition to previously obtained data; yet before accepting them they ought to be confirmed by further tests. Mr. Smith calls attention to the remarkably heavy pressure which the specimen pieces sustained, considering that this pressure was borne theoretically by a line of contact only.

> Just how wide this contact surface was, we unfortunately do not know, as no means were at hand to measure it. Furthermore, I do not know of any definite method for doing this having been devised, there being nothing of the kind at the arsenal in question. I have in contemplation, however, some future tests where this important point will be taken account of, and wherein some possible methods of measuring these indented contact surfaces, which I have in view, will be tested. Of course, the maximum pressure lies along the central element of the indentation, disappearing gradually towards the edges, where it is *nil.* We therefore should naturally expect a considerably less compressive strength per square inch upon the surface in question than upon flat and parallel surfaces, as in ordinary testing. It will be seen by the report, however, that contact surfaces ¾ inch long, and of some unknown width which probably did not average ⅛ inch, stood ultimate pressures varying from about 128,000 to 184,000 pounds. Now, if these surfaces had been of the same width and both flat, they would doubtless, as above intimated, have stood still greater pressures upon this area which probably amounted to less than one-tenth of one square inch. If we assume this area, and that if flat it would have stood 200,000 pounds only, and if, furthermore, we assume that one square inch of metal would bear a pressure in proportion, we should have some remarkable figures, amounting to 2,000,000 pounds for the said square inch. This

strength at first sight seems, of course, entirely incredible, and yet, there it was.

Was there possible error in these tests that made them give the enormous result computed by Mr. Smith? Is his assumption that no more than one-tenth of a square inch was the area subjected to extreme pressure too small? Is there some property of the cylindrical form that enables it to resist pressure on the surface of contact more than the prismatic form? These are questions that will arise in the minds of mechanical engineers, and the answers to which need the further experiment which Mr. Smith says he contemplates.

Friction Rollers.

ALMOST exactly in line with the experiments at Watertown Arsenal, described by Mr. Smith, is an account of other interesting experiments given in a paper presented at the convention of the Am. Soc. C. E., held in June, 1894, the first part of which was prepared by C. L. Crandall, M. Am. Soc. C. E., the second part being by Prof. A. Marston, Assoc. M. Soc. C. E. The paper is published in the Transactions of the Society (August number) together with the discussion elicited.

The paper treats first of a series of experiments upon rolling friction performed at the college of civil engineering, Cornell University, in 1886, by Mr. C. B. Wing, now professor of structural engineering, at Leland Stanford University. The account of the methods employed, and the tabulated results given, though of interest and value, are not, however, what is above spoken of as in line with Mr. Smith's investigations. The experiments performed in 1887, by Prof. Wing, as fellow in the college, and Mr. Crandall, the author of the first part of the paper under review, were made to determine the life of rollers for different loads and material. Mr. Crandall states that these tests were performed in the following manner.

They (the rollers) were placed between upper and middle plates and two between the middle and lower plates with their axes all parallel. The full load on the upper plate was thus divided between the two lower ones. The center plate was driven back and forth about ¾ inch, for rotating the rollers by means of a small water wheel acting through a connecting rod upon a rod working in guides and attached to the plate by a flexible joint. The number of turns of the crank was registered by an attached odometer. The scale beam was kept balanced at a constant load during the experiment. Motion was continued until the surfaces were injured by wear; but it was found impossible to reach the same degree of wear with all, first on account of the difficulty of examining the surface until the experiment was stopped and the rollers removed, and second, on account of the long time required to produce wear with the lighter loads.

The wearing effect was toward a gradual rusting of the surface, which changed to a blackening, accompanied with black dust of worn-out material as the wear increased; finally pitting of the surface took place, with a flow of metal at the ends of the rollers and around the edge of the contact portion of the plate.

The elastic limit in compression of a short steel rod about 1 inch in area, cut from the rod which furnished the smaller rollers, was found to be 46,000 pounds, and the modulus of elasticity 31,500,000 pounds. The cast iron gave an elastic limit in a short length of 41,000 pounds, an ultimate of 100,000, and a modulus of elasticity of 14,400,000 pounds, all in compression.

A table of results is given which includes the date of each experiment, number of odometer revolutions, load per lineal inch of roller, different materials of which rollers were made, the materials of which the plates were made, and the condition of both plates and rollers at the end of the tests. Investigations extended to bridge rollers are also noted.

The second part of the paper contributed by Prof. Marston, is, however, in line with Mr. Smith's investigations, and it is one of the most scientific studies of the distribution of stress in rollers subjected to pressure that has appeared in print. The text occupies 22 pages of the Transactions and there are 5 pages of plates. Only the careful perusal of the paper can give any adequate appreciation of the refined scientific methods employed in the investigation, which is based upon "the fact that stressed glass bodies exhibit striking optical effects when viewed by polarized light." This familiar class-room experiment has been applied by Prof. Marston to the investigation of bridge roller stresses, and the diagrams illustrating optical effects as indicating lines of stress are of very great interest. In a number of cases these effects are illustrated by well executed, tinted engravings, which very much enhance the interest of the paper. A full description of the apparatus employed is given and is illustrated by an engraving. The conclusion is reached that lines of stress in bridge rollers (and inferentially in all rollers of similar materials and analogous use) are what they appear to be in the optical tests, at least approximately—lines of circles. This conclusion is derived mathematically from subjecting the middle lines of the dark bands obtained in the optical experiments to a comparison with lines platted from the equation of the band, under the supposition that the lines of stress are circles; the coincidence was sufficiently marked to justify the conclusion. Several tables are presented, and table No. 4, gives areas of contact obtained by three independent methods, which will be of service in future investigations upon this subject. The paper is in every way a most admirable contribution to current engineering literature, and exhibits a striking example of the refined methods of modern physical research as applied to engineering problems.

Centrifugal Whirling of Shafts.

MR. GEO. R. BALE, Assoc. M. Inst. C. E., has written an article on the above subject for the *Practical Engineer* (London) which s printed in its issue for Sept. 28. The reatment of the subject is both diagramtic and mathematical, and it places in a lear light the importance of considering he subject in the determination of the poitions for shaft bearings, in order to preent the continued revolution of shafts upported by the bearings) in a bent form, vhen any small deflection is imparted to hem. The line of demonstration pursued y the writer is as follows:

From the reasoning given by Prof. Rankine ‘ Millwork," p. 549) we may deduce the followg formula, giving the limit of length between bearings, which should not be exceeded, for a solid wrought iron or steel shaft—

$$L=175\sqrt{\frac{D}{N}}$$

D, being the diameter of shaft in inches,

N, its speed in revolutions per minute, and

L, the greatest admissible length between bearings in feet at which distance the centrifugal force of a slightly bent shaft and the elastic stress tending to straighten it become equal at the given speed. With a less distance between the bearings, centrifugal whirling of the shaft will not take place, as it restores itself to straightness.

By the aid of the above formula the diagram herewith has been plotted, giving the value of L for shafts up to 12 inches in diameter, and for speeds running up to 800 revolutions per minute, by means of which this limiting distance may be readily determined, thus: Suppose we have as our conditions a shaft of 3 inches diameter, running at a speed of 600 revolutions per minute, and it is required to know the maximum distance that may be allowed between the bearings.

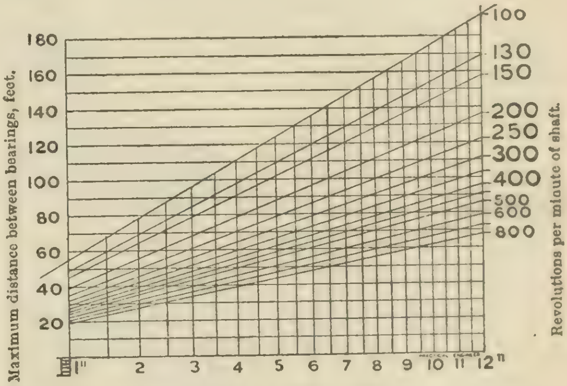


Diagram giving maximum distance between bearings for rotating shafts at which centrifugal whirling does not occur.

At the point marked 3 inches on the scale of diameters of shaft at the base of the diagram, note the intersection of the ordinate with the line marked 600 on the scale of the speed of shaft to the right of the diagram, and read off the corresponding value for L—*i. e.*, 39 feet. Or, again, let us take the case where the position of the bearings and speed of running are fixed by circumstances; then to determine the diameter of the shaft such that centrifugal whirling shall not occur. If L=45 feet, and the shaft is to make 600 revolutions per minute, then D, irrespective of its size necessary for transmitting the power required, should not be less than obtained from the diagram thus: Follow the line marked 600 on the speed scale to the right of the diagram, until the distance between it and the base corresponds to 45 feet by the scale given for L on the diagram, at which point read off the diameter required—*i. e.*, 4 inches—on the diameter scale at the base of the diagram.

For a hollow shaft the formula given above becomes

$$L = 175 \sqrt[4]{\frac{D^2 + d^2}{N^2}} \text{ feet.}$$

D being the outside diameter of the shaft in inches;

d, the diameter of the hole through the shaft in inches;

N, the speed in revolutions per minute, as before, and

L, the maximum distance between bearings, as before, in feet.

Draughting Room Practice.

THE relation which the draughting room ought to bear to other departments of a manufacturing establishment; the method which will render this department most valuable in its effects upon other departments; the function of drawings as expressing ideas of mechanical objects to be constructed; the importance of careful arrangement, classification, and indexing of drawings, so that each may be readily referred to as needed; the sizes most convenient for use (all things being considered), with examples of indexing by the card catalogue system, together with other matters of interest pertaining to the management of draughting rooms, are treated in a good practical article written by Mr. Walter B. Snow, and printed in *Machinery.* This paper, by the way, is a new venture in the field of American technical literature, and should not be confounded with the paper of the same name published in London. The practical side of machinery construction appears to be the tendency of most of the articles which have appeared in the first two numbers. Mr. Snow's article is directed to greater refinement of practice, and more exact and uniform systems with reference to drawings than is usual in many shops.

An Electro-Magnetic Clutch.

AN interesting mechanical device depending for its action upon the attraction existing between an electro-magnet and its armature has been invented by M. B. Bovet of Paris, and is described in *The Safety Valve* (September 15). As this clutch is a decided innovation in mechanical engineering, illustrations of it are given herewith, the cuts having been kindly loaned us by the publishers of the journal quoted.

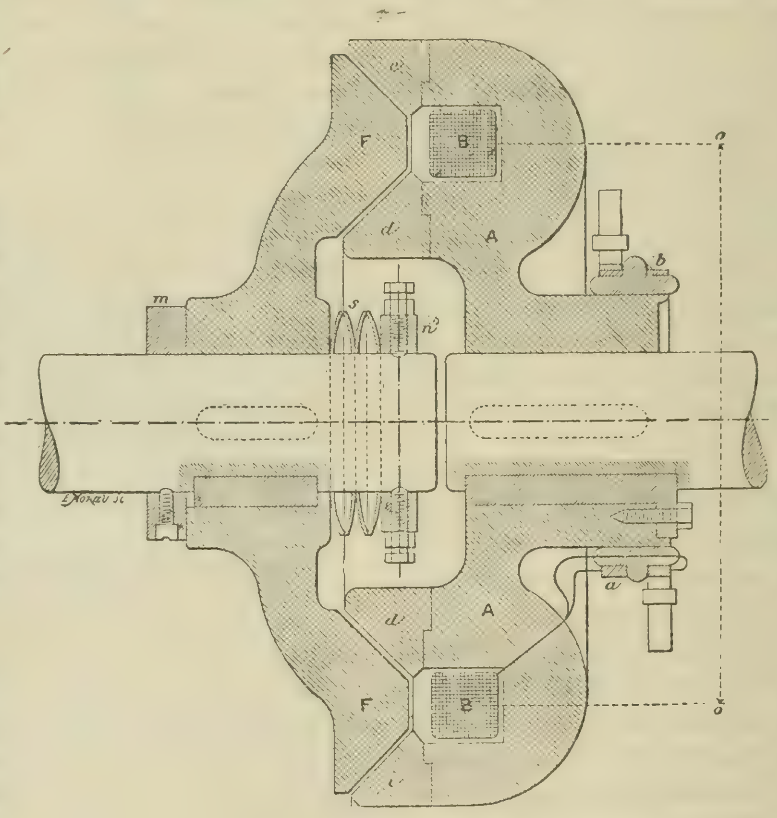


FIG. I.

In Figure I, A is an electro-magnet keyed on the end of a shaft. The current is brought in coil B by means of brushes acting on taking up current rings *a* and *b*. The jaws *c* and *d*, being liable to wear by slipping friction, are set in so as to be easily replaced. Rim F, acting as an armature to the electro-magnet, forms the rim of a wheel keyed on the end of another shaft in such a manner that it cannot turn upon it, but liable to move according to the axis. The displacement is limited by two fixed rings m and n, the motion being produced in one direction by magnetic attraction, and in the other, when magnetic attraction becomes insufficient or is suppressed, by the action of spring S. The jaws c and d are fitted in, in order that they may not only be replaced when worn out, but also to enable them to accentuate the action by giving relatively less thickness to piece F, and, consequently, less resistance. It is believed that if it was built with a more permeable metal than the one with which the electro magnet is made of, it would be better still, and that in a general way, whether one acts on the nature of the metal, or on the sections of thickness, or on both together, it will always be advantageous to close the magnetic circuit in as short a circuit as possible by a piece, which, by provoking magnetism near the contact surfaces, magnetism will cause a decrease of resistance which will in turn cause an influx of force.

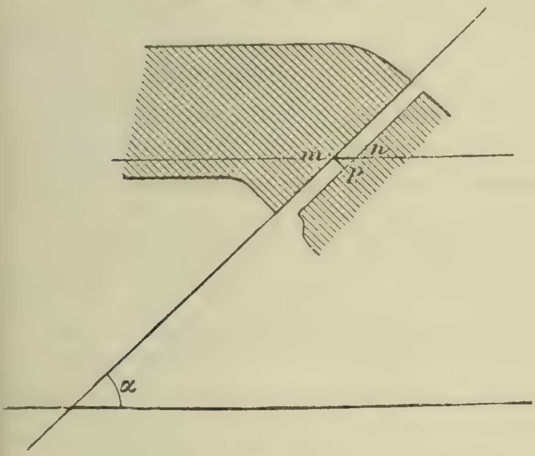


FIG. 2.

The Safety Valve points out that "the wedge shape of the jaws gives a noticeable play to the movable part, while always keeping the active faces near enough together so that the attraction up to contact may be caused by a magnetic field of small ntensity and too weak to cause driving." Referring to Figure 2, M. de Bovet says:

> "We consider it especially necessary to preerve the wedge shape of the jaws, because with uch a shape, to a given displacement $m\,n$ of the rmature according to the axis there corresponds much less distance $m\,p = \sin a$ of the acting urfaces."

Combined Section Liner and Triangle.

MR. F. R. HONEY, whose name will be amiliar to a great many American readers, as a contributor to technical journals, has communicated to the *American Machinist* an account of a new drawing instrument which can be used for all the purposes of a triangle, while it also may be used as a section liner, when the flat shading of a cross section is required. Now there have been various attachments to triangles invented before, and the handy device under consideration would not therefore attract much attention except for certain features of its construction that appear to be new, and also appear to largely increase the range and usefulness of this labor-saving device over others that have preceded it. The monotonous and tedious labor of cross hatching by the old method is one that all draughtsmen would be glad to have lightened and facilitated; and by the use of this new attachment, which can easily be fitted to any triangle, it would seem that a material saving in time, strain of vision, and back-ache, can be accomplished. Mr. Honey has previously described in the same paper a section liner devised by himself. This one, however, has been contrived by Mr. O. F. Hill, of Lowell, Mass. The *American Machinist* has obliged us with a loan of the cuts illustrating the device, which are here reproduced. Referring to these, the following is Mr. Honey's description of the device and the manner of using it:

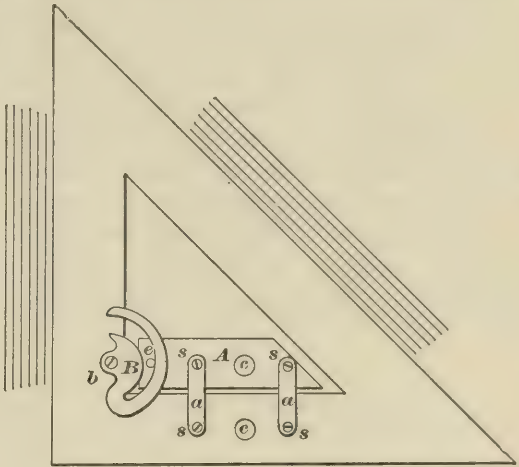


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Fig. 1

> "Figure 1 is an ordinary 45 degree triangle. Within the opening space is a piece A of the same thickness as the triangle, and pivotally united to it by the parallel links a, a, and the

screws *s*, *s*, *s*, *s*. *B* is a cam-shaped gage, which is also pivotally united to the triangle by the screw *b*. This gage overlaps the piece *A*, which carries a pin *e*. This pin engages in the curved groove or opening in *B*. The opening in *B* gradually widens from one end to the other, and the position of the gage determines the throw of the instrument when it is set to regulate the distance between lines. Figures 2 and 3 illustrate extreme positions of the gage. In the former the pin entirely fills up the opening, and there is no throw to the instrument, while in the latter the throw is a maximum.

"In operating the section liner it is desirable to place the lower edge of the triangle in contact with the blade of the T-square in order to correct any tendency it may have to twist out of position. In covering small areas, however, this is unnecessary.

"The right-hand edge of the groove bears against the pin *e*, as shown in Figure 1, and a line is ruled along the long edge of the triangle. The piece *A* is then moved to the left until the pin strikes against the left-hand edge of the groove. The triangle is then moved to the left until the pin bears against the right-hand edge of the groove, thus regulating the space between the lines. The second line is ruled and the operation repeated.

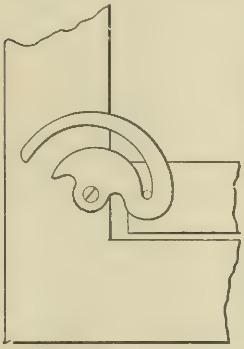

Fig. 2

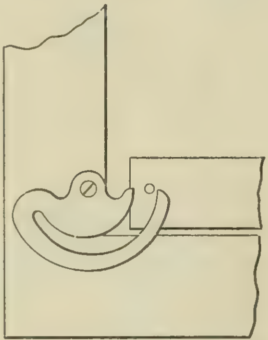

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Fig. 3

"The perpendicular edge of the triangle may also be employed if required by moving the triangle from left to right, instead of from right to left, as above described.

"In moving the triangle the finger should be placed on the piece *A* to prevent it from slipping, and in moving the piece *A* the finger should be placed on the triangle for the same reason. The holes *c c*, which are bored into the triangle and piece *A*, are designed to receive the tips of the fingers, which may remain in these positions while the instrument is in use, one finger sliding one piece into a new position, while the other finger holds the other piece firmly against the paper.

"It will be seen that the width of the spacing may be increased indefinitely beyond the limits controlled by the gage by omitting one or more lines."

As no intimation is given that the attachment has been patented or placed on sale, it is presumably free to be used by any draughtsman who desires to do so; and it is so simple that almost any one will be able to construct it and attach it to a triangle.

Boiler Insurance Inspection.

OUR excellent contemporary, *The Safety Valve*, has commenced a campaign directed to securing improvement in systems of boiler inspection and insurance. In furtherance of this commendable purpose it has been giving liberal and well-prepared abstracts of laws of various countries regulating the use of boilers and editorially and otherwise presenting much which bears directly upon this important subject. An abstract of a report made by Mr. E. G. Hiller to the National Boiler Insurance Company, England, on Boiler Insurance Inspection in England, continued from the August number of the same journal and which is entitled "Insurance Inspection During the Construction of New Boilers," is printed in the issue of Sept. 15 and is a valuable paper worthy the careful and thoughtful perusal of every one interested in the use of steam boilers for power purposes. Mr. Hiller in his paper advocates the aid of insurance inspectors at the very outset of boiler building from specifications. He says with reference to this aid, that in England the National Boiler Insurance Company sends an inspector to attend "at the plate makers when the plates are rolled and mark the plates with the company's stamp, and also to mark pieces for shearing off to be tested for tensile strength and elongation. Thereafter the supervision of the inspector is continued at suitable stages of the work. The title should have been extended to include inspection after completion for this is also treated of in Mr. Hiller's valuable paper, and the details of this inspection are given for which the reader must consult the article itself. Such a system of inspection would inevitably result in permanently advancing the art in the United States. The insurance inspection of boilers is not here frequently directed to the construction of boilers under construction from specifications, yet there appears to be no reason why this could not practically be carried out here as well as in England.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

The Machine Shop.

25014. A Remarkable Job of Broaching. Ill. (A M–Sept. 13.) 900 w.

25015. Makeshift Indexing. Ill. Oberlin Smith (A M–Sept. 13.) 1200 w.

25016. Chasing. Ill. John T. Usher (A M–Sept. 13.) 900 w.

25227. Tuyere Location. Herbert M. Ramp (A M–Sept. 20.) 1400 w.

25229. Heavy Quarter-turn Belt Drive. Ill. James F. Hobart (A M–Sept. 20.) 800 w.

25234. An Electro-Magnetic Clutch. Ill. (S V–Sept. 15.) 650 w.

25380. Chuck for Drill Grinding Machines. Ill. (Ir Age–Sept. 27.) 900 w.

25383. Hardened Rollers as Pressure Bearings. Ill. Oberlin Smith (A M–Sept. 27.) 1700 w.

25403. A Fluid-Pressure Reversing Gear for Locomotive Engines. Ill. David Joy (R G–Sept. 28.) 1800 w.

25527. A Paper of Pins. Ill. Fred H. Colvin (M A–Oct.) 1000 w.

25529. Draughting Room Practice. Walter B. Snow (M A–Oct.) 1500 w.

25531. On the Resistance of Trains of Mechanism. Ill. Leicester Allen (M A–Oct.) 1700 w.

25567. A Combination Section Liner and Triangle. Ill. F. R. Honey (A M–Oct 4.) 500 w.

25621.—$1.50. Friction Rollers. Ill. C. L. Crandall, with Discussion (T C E–Aug.) 8500 w.

*25680. The Friction Clutch in Theory and Practice. Ralph D. Mershon (E–Sept. 28.) 2500 w.

Steam Engineering.

*24950. Why Some Men Fail as Steam Engineers. W. H. Wakeman (E Mag–Nov.) 3000 w.

24984. An Economical Mill Engine.—The Highest Economy on Record for Mill Work. Ill. (B J C–Sept. 8.) 1200 w.

24985. Burning Small Sizes of Coal.—How It Should Be Done (B J C–Sept. 8.) 1400 w.

25012. Allis Steam Engines, Oiling System and Subsidiary Apparatus in the Eastern Power House of the Brooklyn City Railroad Company (Sc A–Sept. 15.) 900 w.

25162. Hot vs. Cold Cylinder Walls (B J C–Sept, 15.) 1200 w.

25233. The Safety of Steam Boilers and Other Considerations. John MacCormack (S V–Sept. 15.) 1300 w.

25235. Insurance Inspection During the Construction of New Boilers. (Abstract.) E. G. Hiller (S V–Sept. 15.) 1400 w.

*25240. Utility of Exhaust Steam. Leicester Allen (D E–Sept.) 1100 w.

25243. Throttling vs. Automatic Engines. W. H. Wakeman (M A–Sept.) 2300 w.

*25272. Liquefaction in Steam Cylinders. Editorial (Eng L–Sept. 14.) 1400 w.

*25274. The Heating Value of Coals. Walter J. May (C G–Sept. 14.) 1000 w.

25304. Indicator Errors. Correction in Accurate Measurement of Power (B J C–Sept. 22.) 1500 w.

25305. Hunting of Engine Governors.—Causes and Remedies Therefor (B J C–Sept. 22.) 1500 w.

*25319. Some Notes on the Governing of Steam Engines Particularly when Coupled to Dynamos. G. L. Addenbrooke (El–Sept. 14.) 2000 w.

*25365. Engine Cylinder Clearances and Initial Condensation. Ill. Michael Longridge (P Eng–Sept. 14.) 2400 w.

25513. Temperature of Cylinder Walls (R R–Sept. 29.) 3000 w.

*25540. The Corrosion of Boilers and Steamships. C. Ward (P Eng–Sept. 21.) 4600 w.

25559. Boiler Inspection Laws of Germany (S V–Sept. 15.) 1300 w.

25582. Hand-Hole Guards. Ill. (M G–Sept. 29.) 1300 w.

25583. Large Gas Engine Plants.—Are They More Economical Than Steam Plants? (B J C–Sept. 29.) 1300 w.

25585. On the Steam Jacket.—Conclusions Arrived at by Professor Thurston (B J C–Sept. 29.) 500 w.

25709. Some Diagrams from a Brown Engine.—Cause of Loop at Steam Line (B J C–Oct. 6.) 400 w.

25710. Testing Indicators (B J C–Oct. 6.) 1800 w.

25754. The Injector. Ill. Albert E. Edkins (C E N–Oct.) 2500 w.

Miscellany.

24983. Elasticity of Machinery (B J C–Sept. 8.) 700 w.

25031.—$1.50. Notes on Wire Tramways. Ill. A. C. Savage (T C E–July.) 2000 w.

We supply copies of these articles. See introductory

25032.—$1.50. Steam and Electric Cableways for Logging and Canal-Boat Towing. Ill. Richard Lamb (T C E–July.) 2700 w.

25074. Countries Where Piracy of Inventions is Legalized. George G. Turri (I Age–Sept.) 1600 w.

25075. Nature and Policy of Letters Patent for Inventions. Levin H. Campbell (I Age–Sept.) 1800 w.

*25121. Mechanics as a Fine Art. William T. Magruder (E A S–Aug.) 2800 w.

25164. The Prospects of the Gas Engine. J. H. Killey (C Eng–Sept.) 1000 w.

25188. Successful Managers. C. R. Tompkins (A S–Sept. 15.) 900 w.

25230. A Note on Compressed Air. Frank Richards (A M–Sept. 20.) 4300 w.

*25275. Qualities Necessary in Manufacturing Coal. M. Schmidt (C G–Sept. 14.) 3000 w.

25306. Compressed Air for Transmission of Power. Editorial (B J C–Sept. 22.) 800 w.

*25368. Machinery in Court.—The Part Which It Plays as Evidence in Actions (M–Sept. 15.) 1600 w.

*25475. A New Mechanical Fluid (Inv–Sept. 22.) 1500 w.

25526. Sixty Years a Mechanic. — Some Reminiscences of an Old Workman. Joshua Stevens (M A–Oct.) 1300 w.

†25545. The First United States Pneumatic Postal System. A Falkenau, with Discussion. Ill. (P E C P–April-June.) 6000 w.

25566. Some Unusual Movements. Ill. C. L. Redfield (A M–Oct. 4.) 800 w.

24584. Petroleum as a Lubricant.—Its Value and How to Test It (B J C–Sept. 29.) 900 w.

25593. Cost of Power from Prime Movers. G. G. Hiscox (Pr–Oct.) 2400 w.

25604. An Important Prospective Patent Decision. Charles A. Brown (E E–Oct.) 1600 w.

25620. The Long-Running Meteorograph of the Mont Blanc Observatory. Ill. J. Janssen (Sc A–Oct.) 800 w.

25626.—$1.50. The Pulp Mill of the Cliff Paper Company of Niagara Falls, N. Y. Ill. Wallace C. Johnson (T C E–Aug.) 4800 w.

*25667. The History and Development of the Gas Engine. (Abstract) W. Norris (J G L–Sept. 25.) 2000 w.

25718. Superiority of American Machinery (M G–Oct. 6.) 1200 w.

*25725. American Trade Schools. Ill. (I C B–Sept. 28.) 500 w.

*25749. The Motion of a Wheel. Ill. Herbert Aughtie (P Eng–Sept. 28.) 700 w.

Serials.

13534. The Gas Engine (M W–Began June 2, 1893—11 parts to date—30 cts. each).

16781. Rope Driving. J. J. Flather (E W–Began Oct. 26, 1893—12 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El–Began Dec. 1—22 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M–Began Feb.—8 parts to date—30 cts. each).

19709. The Indicator and Its Diagrams. Charles Day (P Eng–Began Feb. 2—17 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E–Began March—8 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Radinger (E M–Began April—7 parts to date—30 cts. each).

23639. Mechanical Draught (E R L–Began July 6—2 parts to date—30 cts. each).

23826. Comparison of Different Formulæ for Dimensions of Parts of Steam Engines. William Kent (A M–Began July 26—4 parts to date—15 cts. each).

24038. Compressed Air.—The Problem of Transmitting Power to Long Distances by Its Use. Ill. (C E–Began Aug.—Ended Oct.—3 parts—30 cts. each).

24338. Gas Engines. David Salomons (P A–Began Aug. 15—3 parts to date—15 cts. each).

24722. Methods of Determining the Dryness of Steam. W. C. Unwin (Eng L–Began Aug. 24—Ended Sept. 7—3 parts—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L–Began Aug. 31—4 parts to date—30 cts. each).

25100. Oil Engines. Ill. William Stafford (P Eng–Began Sept. 7—Ended Sept. 14—2 parts—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y–Began Sept. 19—3 parts to date—15 cts. each).

25381. The Walker Universal Tool and Cutter Grinder. Ill. (A M–Began Sept. 27—2 parts to date—15 cts. each).

25469. Type-Writing Machines. Henry Charles Jenkins (J S A–Began Sept. 21—2 parts to date—30 cts. each).

25528. The Design and Construction of Modern Steam Engines. Theodore F. Scheffler, Jr. (M A–Began Oct.—1 part to date—15 cts).

25538. Testing of Engines and Boilers. Ill. Charles Day (P Eng–Began Sept. 21—2 parts to date—30 cts. each).

25563. Spacing Holes.—Easy Way (A M–Began Oct. 4—1 part to date—15 cts).

25611. Calculation of a Compressed Air Transmission when the Subsidiary Losses of Energy are Taken into Account. From Professor Unwin's "Development and Transmission of Power" (E M–Began Oct.—1 part to date—30 cts).

25735. Notes on the Steam Turbine. Kenelm Edgcumbe (E R L–Began Sept. 28—1 part to date—30 cts).

MINING & METALLURGY

The Genesis of Ore Deposits.*

FEW contributions to the science of economic geology have attracted such attention as Prof. F. Posepny's monograph on "The Genesis of Ore Deposits," presented at the Chicago meeting of the American Institute of Mining Engineers, in August, 1893. The discussion of that paper was continued at the February meeting, and now again at the October meeting at Bridgeport, besides many communications to the mining and geological periodicals, and has elicited much fresh evidence and a variety of professional opinions. Professor Posepny now replies to his critics *seriatim*, and amplifies and further explains the conclusions previously announced by him, dwelling especially upon the conditions of underground water circulation, as bearing upon the much-vexed question of ore deposition by lateral secretion *versus* the ascensional theory. The author re-states his position in favor of the latter theory as the more probable and more generally applicable explanation, giving his evidence therefor, and drawing his deductions in a manner admirably conscientious and free from the slightest taint of dogmatism. It may be remarked here that in the narrow sense in which the lateral-secretion theory of Professor Sandberger was first announced, attributing the sources of ore bodies to the immediate wall rocks, it presented obvious difficulties and for some cases inconceivable conditions, and has latterly been modified and widened, to refer the sources of ore to rocks within "reasonable proximity," with much latitude as to the local direction of the solvent and precipitating currents; so that it has lost much of its precision, and, while offering a more satisfactory general explanation, has somewhat fallen from the dignity of a clean-cut theory. Another point developed in the course of the argument is the manner of deposition of ore and vein matter, whether by successive fillings of open cavities (that is, pre-existing spaces filled only with air or water) or by molecular substitution (also termed "replacement" and "metasomasis"). Professor Posepny regards "crustification"—a more precise term than "banded structure"—as a clear proof and test of deposition in open fissures, caves, vugs, etc.; but does not exclude the metasomatic origin of deposits preserving the structure of the original mass, as sometimes plainly shown. To Professor Posepny's latest utterance Dr. R. W. Raymond has appended a summary of the argument, with comments of his own.

Ore Dressing in Sweden.

METHODS of preparing ore for reduction or for the market in Sweden are described in detail by Mr. P. G. Lidner, with separate accounts of representative works. In that country the mechanical concentration of ores has not attained any considerable extent quantitatively, by reason of the scarcity of ores calling for this kind of treatment, these being limited, with one exception (at the Sala mine, producing argentiferous galena and other silver-bearing minerals), to blende, or blende and galena intimately mixed. But the works are extremely interesting because of the very difficult nature of the material treated, which is of low grade carrying the valuable minerals mostly in a state of very minute subdivision. In the main, the apparatus and methods resemble those of the German plants, the system involving a close sizing and classification of material, separate treatment of the differ-

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*The subject-matter of this and of the four following notices is contained in papers presented at the Bridgeport meeting of the American Institute of Mining Engineers, October, 1894; and the comments upon these papers are based upon advance sheets of the *Transactions Am. Inst. Mg. Engineers* for the current year.

ent classes and sizes by machines especially adapted for each, with a complication of regrindings, resizings, hydraulic classifying, and re-concentration, with the ultimate result of very clean products, the separation of blende from galena being very perfect. The losses in concentration are unavoidably high, owing to the character of the material, which does not lend itself readily to mechanical concentration, and range from 21 up to even 50 per cent. on the finely disseminated blende and galena mixed ores. The advocates of close sizing will find, in the examples described, model plants with numerous sizing drums, ore classes, subdivisions and re-treatment; but the author leaves it to the reader to form an opinion whether the same results could not be obtained in a simpler way and by a less complex system. As to the careful preparatory work of sorting and hand-culling, which deserves attention because it effects a greater saving than is generally supposed, Mr. Lidner does not recommend in American practice the carrying of hand-work so far as in Europe, because wages are higher; but believes that this preliminary operation is too much neglected in the United States, and that many concentrating works, especially in the zinc-mining districts, would profit by paying more attention to it. In Sweden the cheapest labor is employed for the sorting; on the picked, clean ore there is no loss in concentration; there is no wear and tear of machinery by anything thus removed, be it clean mineral or gangue; and both the machinery and the mill work are highly benefited by keeping out broken tools, pieces of iron or wood, rags, etc. A special feature of some Swedish works is the light kiln-roasting of some ores containing worthless pyrite, to eliminate that mineral from the concentration problem where the product of the works is to be pure oxides.

Inaccuracy of the Silver Assay.

WITH the object of convincing the managers of silver mills that the customary calculations in regard to the percentage of silver saved are misleading and often far from the truth, Mr. C. A. Stetefeldt presents a paper on the inaccuracy of the commercial assay for silver, and of metallurgical statistics in silver mills, with special reference to the treatment of roasted ores by amalgamation and lixiviation. Besides the known errors of the commercial fire assay, from silver remaining in the slag, absorbed by the cupel, and volatilized in the crucible melting, scorification or cupellation, there are errors from incorrect sampling and in the weighing of buttons. The losses in slag or by absorption may be ascertained with practical accuracy by reassaying the slag and cupel, and adding the result to that of the button, thus obtaining a "corrected" assay. The loss by volatilization is an unknown quantity, the author thinks, which cannot be ascertained even by synthetic methods. Recent researches however have thrown considerable light upon this question. Mr. Stetefeldt tabulates the results of numerous assays at different mills, by different assayers, and brings out some remarkable discrepancies between the commercial and the corrected assays. The latter are the highest returns obtainable in ordinary practice and without specially refined methods, but as the former (the commercial assays) are commonly taken as a basis in reporting percentages of silver saved and lost in actual treatment, the apparent results may evidently be far astray. What the author charges against the common practice in mill work of course holds good as to smelting, though at smelting establishments the sampling and assaying are performed with greater care.

Manganese Slags at Tombstone, Arizona.

THESE form the subject of a communication by Mr. John A. Church, in which he records the results of smelting concentrates from silver ores, using low-grade argentiferous manganese ore as a substitute for iron flux. The material treated was extremely unpromising, the difficulty of making a smelting product from slimes containing only three per cent. of lead being only the first of many obstacles to be faced. At the time no smelter had ventured to trust manganese as a precipitant, though large quantities of manganese ore containing silver were bought and used by smelters (as at Butte), who then looked upon manganese solely as a basic flux for silica. On the whole the results of all the runs (1307 days, with 41,626 tons smelted) were fairly satisfactory and certainly formed a unique chapter in the history of smelting. Although silver-lead smelting is now on a different footing from what it was in 1882-86, when the plant at Tombstone was running, and the conditions of transportation and smelting charges have changed, the experience then gained is still instructive.

Does the Vibration of Stamp Stems Change their Molecular Structure?

THE controversy over the question of the crystalization of iron and steel by vibration and repeated shocks, or rather as to the validity of that theory as an explanation of the breakage of stamp stems, is by no means yet settled. Messrs. Argall and Austin on the affirmative and Dr. Raymond on the negative stoutly maintain the battle, with extended argument, observations and reference to authorities. By common consent the question has been narrowed down to the concrete case of the battery stems, or in other words to the causes of the breakage of wrought iron and specially worked mild steel under limiting conditions, in the cold and under specified stresses. It is hardly necessary to say that the argument has been conducted with much keenness and ingenuity on both sides. To attempt to recapitulate or summarize it with the space available here would be to do injustice to the able contestants and would present a very imperfect view of the case to the reader, who must be referred to the entire debate in the *Transactions*. But as the question is of far-reaching importance in the whole metallurgy and use of iron and steel, and perhaps of other metals also, it may be well to quote the tests proposed by Dr. Raymond, any one of which would prove a good deal: (1) Let a stamp stem which has been running for a long time without breaking be taken down and examined as to fracture and structure; (2) to make this result conclusive, let a comparison be made between such a stem and one made at the same time from the same metal, but not used; (3) let a stem which has broken in service be examined as to its structure at other points than that of fracture; (4) let such a stem be tested to ascertain whether, at any point in it, it is not possible to produce at will either granular or fibrous fracture by simply varying the means and method of fracture; (5) let any stem, new or old, used or unused, be tested in the foregoing manner. It might be supposed that the behavior of stamp stems in actual service would in itself offer conclusive testimony; but a careful examination of the arguments and facts shows that there is something still to be said on either side, and that only systematic tests will be convincing to all.

Does Iron Crystallize in Service?

LOOSE use of terms creates confusion of thought and often leads to needless controversy where the issue is not so much one of fact as of definition. For example, here is the discussion over the question of crystallization of iron and steel in service. Mr. P. Kreutzpointner clears away some of the misconceptions by drawing a sharp distinction between the words "crystalline" and "granular" and defining "fibrous" as applied to these metals, which he does in a carefully prepared article in the *Iron Age*. It has been shown that the best soft iron is liable to break with a "crystalline" fracture under certain conditions, thus giving the impression that it had turned crystalline from its original fibrous state. But now for the definition:

> A fracture is crystalline only when the shining particles are formed with more or less well developed angles bearing the characteristics of crystallization. But there are many fractures of iron and steel which present shiny facets, it is true, but are nothing else than the transverse section of the "fiber" or crushed original crystal which formed while the fluid or semi-fluid mass was slowly cooling and was subsequently rolled out or hammered down and elongated. . . . These elongated crystals cannot be properly called crystals any longer, and hence the fracture . . . exhibiting the transverse section of these [former] crystals in the form of a shiny angular surface is more properly termed

granular. But to many . . . a granular fracture is crystalline in appearance because of the similarity, and they jump to the conclusion that the iron or steel crystalized in service.

This deceptive appearance is well shown by an illustration in the *Iron Age* article of a bar broken short off and having across the end a very marked granular fracture with bright facets, but a longitudinal slice through the middle of the bar proves that these facets are merely the ends of rolled out crystals, that is, "fibers." This sort of fracture is produced by very sudden rupture, when the particles have not time to flow and rearrange themselves. None of the disputants deny that metals are subject to "fatigue" under repeated stresses; but this admits of various explanations. "Fatigue" is a convenient word, which does not tie the user down to any theory.

Curvature of Diamond Drill Holes.

It often happens in prospecting by means of the diamond drill, when the holes are drilled in any direction other than vertical, that false indications are given as to depth and distance. Mr. J. Parke Channing, who has been investigating this source of error, has communicated his results to the Lake Superior Mining Institute, and his paper is reproduced in the *Engineering and Mining Journal.* While drilling a series of fan holes to test the formation on one of the Michigan ranges Mr. Channing found that cores from holes started downward at an angle of 45° did not correspond with the calculated stratification at the supposed position of the bottoms of the holes. Concluding that the angle must have changed, he proceeded to test this by the method of lowering glass tubes containing hydrofluoric acid and noting the angle of the etched ring. The first trial, not wholly conclusive, indicated that at a depth of 531 feet the hole had flattened 15°. After experiencing trouble with different forms of apparatus, the results being vitiated by the hydraulic pressure driving stoppers in and compressing the air, or forcing in water through the plugs and diluting the hydrofluoric acid solution, successive experiments giving no test, Mr. Channing had special tubes made, 1 inch in diameter, 5 feet long, with ground glass stoppers. These also failed at first, the water working in through the ground joint. The final and successful method was, in brief, as follows: The vacant end of the core barrel was plugged tightly with wood; the upper end of the tube warmed and the stopper heated in a little paraffine; the tube placed vertically; 1 inch of 20° acid carefully poured in, then 1 inch of water; the stopper fitted in; the tube, still vertical, was put in the core shell and the latter screwed into the barrel. The apparatus was then lowered with the rods, care being taken to touch the bottom of the hole gently. Experiments as to the time necessary to leave the tube in the hole showed that two hours were as good as twenty-four, but that one hour was insufficient. The angle of etching was read by clinometer. It was also proved that the rods would turn freely with considerable curvature.

In some of the deep holes the point was 60 feet higher and 50 feet farther than if drilled straight. Lateral deviation could not be tested by a tripped compass, on account of local irregularities of attraction. The cause of the holes flattening was found to be that with a new bit on an old core barrel the upper end of the latter had an extra clearance and tended to press down, thus gradually raising the direction of boring.

Electric Smelting of Iron.

The possible application of the Taussig electric smelting process in certain parts of the southern United States is discussed in the *Manufacturers' Record* by a writer who holds rather sanguine views as to the success of that method. After alluding to the introduction of electricity into other branches of metallurgy (as in the production of aluminum, welding, etc.), the experiments of Edward Taussig, of Bahrenfeld, Germany, are described. The process has attracted much comment in the technical press but has not yet been introduced on a commercial scale, though one plant is being erected at Copenhagen and another in the south of France. It consists in first reducing and smelting the ore, with suitable flux, and finally in casting the metal thus produced. The apparatus consists of a long air-tight smelting chamber in which the hearth inclines toward a central opening through which the metal passes into the mold. The furnace is lined with glazed firebrick. As no carbon is present the metal is "almost pure" and the rarefied atmosphere (also described as a "vacuum") "removes any gases produced, prevents oxidation or blistering, and increases the fluidity of the metal, thus producing castings which are dense and homogeneous." If steam is to be used to run the dynamo, the writer claims a large economy of fuel as compared with other smelting methods; but more conservatively explains that the most advantageous application of the process would be in places where ores exist near to some available water power or where fuel is high-priced and water-power can be transmitted without too great loss. It is also suggested that an electric generating plant might be erected near coal mines and power obtained by using slack coal in producers, heating the boilers with the gas, and transmitting the current from the dynamos to electric smelting furnaces at the iron mines. The author of the paper considers that if full success is attained in the European plants the south would be an exceptional field for the process, owing to the numerous water-powers at hand. He enters into details as to cost and results, which have already been widely published, and appears to be more hopeful than the many metallurgists who consider the electric smelting of iron ores to be a little ahead of the times, however promising it may seem as a method for the indefinite future to develop.

Natural Gas in Indiana.

THE full text of the last report of Mr. Jordan, inspector of natural gas for the state of Indiana, is quoted in the *American Gas Light Journal.* Occasion has been taken in a previous issue of THE ENGINEERING MAGAZINE to refer to the yeoman's service rendered by this active officer in striving to check the waste of natural gas and to prolong its usefulness as far as this can be accomplished by measures adopted at this late day. It is known, from bitter experience, that the stock of natural gas in any area (and the productive areas are limited) is a rapidly exhaustible quantity, and that if, as is doubtful, gas is being generated at present, it is in quantities insignificant in comparison with the enormous drain both for consumption and through wastage. In Indiana the failure has begun, as is shown by the great reduction in pressure; while in parts of Pennsylvania and Ohio the exhaustion is already complete. Considering the vast investments in manufactories dependent on natural gas, the question is a most serious one. Mr. Jordan says:

> The gravity of the situation can only be understood when it is known that from 225 to 250 pounds pressure at the head of the main lines is absolutely necessary to force the gas to the different cities that lie outside but are obtaining their fuel from the gas field, with sufficient pressure to distribute it through the low-pressure city lines to the consumer. . . There remains now but a small average margin above the limit of low pressure. At the annual rate of reduction, and by a continuance of the present extravagant and wasteful method of consumption, this small margin will be spent . . in a very short time. When this shall have happened, artificial pressure by means of pumps will be resorted to. . . It has been the experience of other states that when the initial pressure must be supplemented by artificial means the end is very near at hand. A careful study of the conditions of the field in Indiana as they exist to-day will show that we have almost reached that point.

As remedies, Mr. Jordan offers the following common-sense suggestions: (1) All gas should be sold by meter measurement, and this should be enforced by law; (2) natural gas should not be used in the manufacture of bricks, tiles, nor in the rolling mills nor melting furnaces of glass factories. In these works a coarser and less valuable fuel can be used. The inspector rightly adds that the highest and best purpose to which natural gas can be applied is the domestic use. It is in this use that it does the greatest good to the greatest number, and it is for this use that it should be preserved.

Mining Experts.

MUCH has been said, written and printed about the qualifications, functions and responsibilities of mining experts, but there always seems to be room for a last word, and this the *Mining Journal* now utters. Recent occurrences in South Africa, and possibly in the new gold fields of West Australia, cause the *Journal* to take up the subject anew and call the attention of English investors to some of the aspects of the situation. When mining properties are offered upon the market, a very grave responsibility rests upon the experts sent out to examine and report upon them. This is strongly felt by a man who knows that a favorable opinion by him will probably entail a heavy expenditure on the part of his clients. In addition to the technical training, practical experience and business acumen necessary to the real expert, there is obviously demanded a quality independent of these—a moral sense and integrity that will inspire confidence and be a guarantee not only of good professional judgment but of good faith. The *Journal* is quite right in insisting that only the best and most reliable of men should be chosen for work of this sort; men fully alive to the responsibilities involved. Much saving of money and the diminution of mining failures would have resulted from better selection of experts. "Unfortunately," remarks our contemporary, "during the rush and excitement due to the discovery of a new and rich gold field, ordinary business precautions seem to be neglected and the statements of unknown men are accepted as being absolutely true, while the necessity of their confirmation is lost sight of." Afterward the investors find out their mistake. It might be added that it is always easy to get the professional rating of any man who sets up as an "expert."

A suggestion that we do not remember having seen put forward in print before is offered by the *Mining Journal*—namely, that instead of sending in his report, the expert should if possible submit it in person and be cross-examined thereon by his employers, for there are many points which may be omitted from a written report upon which his views and opinions, as one who has been on the spot, would be valuable. Apropos of the form and weight of reports the *Journal* might cite as an instance of a very convincing sort the story of the American expert who returned from making an examination and said to his client, drawing out his check for $5000: "That is all the report I need make. Let me into the deal."

Regarding mine salting, the *Mining Journal* perhaps lays too much stress upon the danger; but concedes that in the majority of cases the vendors are honest in their dealings, though of course anxious to make the most favorable terms. A more common trouble the expert has to encounter is the overestimate that holders always have and the partiality of all neighbors to put the best face upon matters concerning which testimony rather than observation has to be relied on. So far as personal examination goes, sampling, when properly and conscientiously done, is more accurate than our contemporary is inclined to believe. This can readily be put to the test of a trial mill run or sale of ore to a smelter, and of course the expert will resort to these larger metallurgical tests whenever the transaction is of importance.

Finally, as to fees: "The duties entrusted to a mining expert are about as onerous as can be confided to any one man, and we are decidedly of opinion that his fees, even though stiff, are well earned." As a percentage on the money involved they are disproportionately below the fees of architects and civil engineers; besides, the mining expert has to charge for much lost or unoccupied time. The value of a negative report is not always appreciated by would-be investors.

AMERICAN coal, says *Black Diamond*, has possession of the Havana market, to the nearly total exclusion of English, but in Jamaica the English fuel is used far more than the American. The ascendency of American coal in Cuba is a commercial victory, and the conditions in other parts of the West Indies and in portions of South America are substantially the same as in Cuba.

PROGRESS in electric mine-hoists is shown by a two-motor, double-reel hoist described and illustrated in the *Mining and Scientific Press.* Each motor is of 500 horse-power; combined, 1000 horse-power. The reels are for flat steel cables, and the hoist is designed to raise a load of 5 net tons from a depth of 2500 feet in one minute. This is probably one of the most complete hoists yet made.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

*24949. Present Status of the Nickel Industry. William L. Austin (E Mag–Nov.) 3000 w.

25071. The Taussig Electrical Smelting Process and Its Possible Utilization in the South (M R–Sept. 14.) 1100 w.

*25102. Tin Plate Manufacture. South Wales vs. America (I & S–Sept. 8.) 900 w.

25173. The Fairfield Copper Company. Maurice Barnett (E M J–Sept. 15.) 1800 w.

25174. Experiments with Zinc Ores in a Blast Furnace. H. Hunicke (E M J–Sept 15. 900 w.

25213. Iron and Steel Statistics for 1893 (E N–Sept. 20.) 1100 w.

*85342. The Principles of Jigging. Editorial (M J–Sept. 15.) 2500 w.

25378. Do Iron and Steel Crystallize in Service? Paul Kreuzpointner (Ir Age–Sept. 27.) 1800 w.

25416. The Murphy Gold Process. J. G. Murphy (M S P–Sept. 22.) 3000 w.

†25432. Solids Falling in a Medium. F. M. F. Cazin (Tr A M E–Oct.) 3500 w.

†25433. Close Sizing before Jigging. Ill. Robert H. Richards (Tr A M E–Feb.) 8400 w.

†25434. Aluminum-Bronze. Leonard Waldo (Tr A M E–Feb.) 1500 w.

†25438. Magnesia and Sulphur in Blast-Furnace Cinder. Frank Firmstone (Tr A M E–Oct.) 1300 w.

†25439. A Uniform Method for the Assay of Copper—Materials for Gold and Silver. Albert R. Ledoux (Tr A M E–Oct.) 2600 w.

†25440. The Inaccuracy of the Commercial Assay for Silver, and of Metallurgical Statistics in Silver-Mills, With Special Reference to the Treatment of Roasted Ores by Amalgamation and by the Russell Process. C. A. Stetefeldt (Tr A M E–Oct.) 2500 w.

†25441. Does the Vibration of Stamp-Stems Change Their Molecular Structure? Continued Discussions of Mr. Rickard's paper "The Limitations of the Gold Stamp Mill" (Tr A M E–Oct.) 5500 w.

†25442. The Manganese Slags of Tombstone, Arizona. John A. Church (Tr A M E–Oct.) 2500 w.

†25444. Ore-Dressing and Concentration in Sweden. P. G. Lidner (Tr A M E–Oct.) 4800 w.

*25472. The Bessemer Steel Industry and the Nail Manufacture. Ill. Henry Bessemer (E Rev–Sept. 20.) 1100 w.

*25486. Bell-Founding (I C B–Sept. 21.) 2000 w.

25530. Forty-five Tests of Malleable Iron. Ill. George L. Fowler (M A–Oct.) 1500 w.

†25551. The Detection and Approximative Estimation of Minute Quantities of Arsenic in Copper. F. A. Gooch and H. P. Moseley (A J S–Oct.) 1200 w.

*25574. Improvements in the Cyanide Process. Editorial (M J–Sept. 22.) 1200 w.

25629. Are Iron and Steel Crystallized by Vibration? (E N–Oct. 4.) 3000 w.

*25685. The Cowper-Cole's Galvanizing Process. Ill. (Eng L–Sept. 28.) 2800 w.

25712. The Blast Furnace. E. C. Potter (I T R–Oct. 4.) 2600 w.

*25728. A New Method of Smelting Pyritic Ores (Inv–Sept. 29.) 2200 w.

Mining.

*24953. The World's Production of Gold. T. A. Rickard (E Mag–Nov.) 3000 w.

24956. The Malacate Silver and Gold Mines of Sultepec, Mexico. Edward Halse (E M J–Sept. 8.) 2100 w.

24957. Coal Mining in Iowa. G. A. Davis (E M J–Sept. 8.) 1200 w.

24964. Electricity and Mining. Editorial (B D–Sept. 8.) 1000 w.

24987. Natural Gas in Indiana During 1893—Report of Mr. Jordan (A G L J–Sept. 10.) 5200 w.

*25063. Cableways for Quarries. Ill. Spencer Miller (S–Sept.) 3000 w.

†25083. Rubber Hose for Hydraulic Placer Mining. Albert Williams, Jr. (I R W–Sept. 15.) 2800 w.

*25112. A Bold Mining Engineering Work.—Enterprise in the United States. Ill. (M J–Sept. 8.) 2800 w.

*25113. Explosions in Nova Scotian Coal Mines. Edwin Gilpin, Jr. (M J–Sept. 8.) 4200 w.

*25114. On the Origin of Gold in Quartz Veins. Henry Louis (M J–Sept. 8.) 3000 w.

*25115. Mining Experts. Editorial (M J–Sept. 8.) 1200 w.

*25120. The Mining Interests of Nova Scotia. Frank Cowley (E A S–Aug.) 3300 w.

*25130. The Law as to the Removal of Mining Fixtures and Machinery (C G–Sept. 7.) 5000 w.

†25145. English Money in American Mines. A Practical Miner (W R–Sept.) 3500 w

25171. A. Walrath et al. vs. Champion Mining Company, with Editorial (E M J–Sept. 15.) 5000 w.

25223. On the Chemistry of Coal Formation. J. W. Thomas (Sc A S–Sept. 22.) 2200 w.

*25325. The Coal Industry of India (B T J–Sept.) 1000 w.

25336. Curvature of Diamond Drill Holes. (Abstract) J. Parke Channing (E M J–Sept. 22.) 1200 w.

25339. The Prevention of Mine Litigation. Francis F. Freeland, with Editorial (E M J–Sept. 22.) 1600 w.

*25340 Colorado's Gold Resources (M J–Sept. 15.) 2500 w.

†25362. Stone Burning. F. J. E. Spring (I E–Aug. 25.) 800 w.

†25435. The Structure of the Richmond Coal-Basin. Ill. E. J. Schmitz (Tr A M E–Oct.) 3000 w.

†25436. The Geological Structure of the Ringwood Iron Mines, New Jersey. Ill. Frank L. Nason (Tr A M E–Oct.) 4000 w.

†25437. The Ore-Deposits of Butte City. R. G. Brown (Tr A M E–Oct.) 5500 w.

†25443. The Genesis of Ore Deposits. Continued Discussion of paper by Bergrath F. Posepny (Tr A M E–Oct.) 1400 w.

*25446. Explosions from Coal-Dust in Mines. Editorial (E–Sept. 21.) 3300 w.

*25452. The Iron Industry of European Russia. Hugh O'Beirne (C G–Sept. 21.) 5700 w.

*25457. The New Primrose Gold Mine. Ill. (I & I–Sept. 21.) 3300 w.

25464. Waste of Coal in Mining. Selwyn M. Taylor (A M & I W–Sept. 28.) 1800 w.

*25470. Production of Manganese Ore in the Caucasus (J S A–Sept. 21.) 1000 w.

25502. A Model Southern Coal Mine.—The Plan of Operations at the Soddy Coal Mines. R. A. Bowie (T–Oct. 1.) 900 w.

25636. "Desert" Mines of California. Ill. (M S P–Sept. 29.) 2500 w.

25638. The Nationalization of the Mineral Domain of Ontario. J. Bawden (C M R–Sept.) 5000 w.

25639. On Cage Conductors in Shafts. Ill. T. C. Hair (C M R–Sept.) 6000 w.

25640. The Colliery Fireman.—His Training, Treatment, Position and Duties. George Elce (C M R–Sept.) 3500 w.

25668. Cost of Coal Mining in Iowa. (Abstract) G. A. Davis (A M & I W–Oct. 5.) 1000 w.

*25686. The Boulonnais Coalfield. Marcel Bertrand (C G–Sept. 28.) 7700 w.

*25687. The Sydney Coalfield of Cape Breton, Nova Scotia. Hugh Fletcher (C G–Sept. 28.) 2200 w.

*25688. Lignites in Spain (C G–Sept. 28.) 1000 w.

25719. Leadville's Gold. Editorial (M I T–Oct. 4.) 900 w.

25722. Bridgeport Meeting of the American Institute of Mining Engineers, with President Fritz's Address (E M J–Oct. 6.) 8500 w.

Miscellany.

25641. Photography in Mines. Herbert W. Hughes (C M R–Sept.) 6500 w.

Serials.

20413. Mining Methods. Ill. (C E–Began March—8 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E–Began March—8 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E–Began March—8 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E–Began March—8 parts to date—30 cts. each).

21369. Press Working of Sheet Metals. Ill. Oberlin Smith (Ir Age–Began April 19—8 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng–Began April 27—8 parts to date—30 cts. each).

22586. The Mineral Hydro-carbons. Henry G. Hanks (M S P–Began June 2—13 parts to date—15 cts. each).

22710. Science for Ironmongers (Irm–Began June 2—10 parts to date—30 cts. each).

24277. From Iron Ore to Steel.—A Sketch of Iron Mining and Manufacturing in Pictou County, Nova Scotia. Joseph Dix Fraser (C Eng–Began Aug.—Ended Sept.—2 parts—15 cts. each).

24362. Methods of Mine Timbering. Ill. (M S P–Began Aug. 11—4 parts to date—15 cts. each).

24802. Shaft Sinking and Equipment.—With Special Reference to Comparatively Shallow Basins. J. T. Beard (C E–Began Sept.—2 parts to date—30 cts. each).

24876. Methods of Mine Timbering. Ill. W. H. Storms (Sc A S–Began Sept. 8—4 parts to date—15 cts. each).

24918. The French Northern and Belgian Coalfield. Ill. Marcel Bertrand (C G–Began Aug. 31—2 parts to date—30 cts. each).

25277. Centrifugal Fans. (Abstract.) Paul Habets (C G–Began Sept. 14—2 parts to date—30 cts. each).

25337. Zinc Ore Separating Plant at Monteponi, Sardinia. Ill. (E M J–Began Sept. 22—2 parts to date—15 cts. each).

25384. Rustless Coatings for Iron and Steel. Ill. M. P. Wood (A M–Began Sept. 27—2 parts to date—15 cts. each).

25572. Mineral Resources of the United States. John Birkinbine (M J–Began Sept. 22—2 parts to date—30 cts. each).

25573. The Extraction of Copper from Alloys by Means of Electrolysis. Carl Schnabel (M J–Began Sept. 22—Ended Sept. 29—2 parts—30 cts. each).

25689. A Typical Gold Mine Region, Cripple Creek, Col. Ill. Arthur Lakes (C E–Began Oct.—1 part to date—30 cts).

Water Supply Engineering.

An article written for *Technic*, by R. C. Gemmell and reprinted in *The Age of Steel* and several other publications, has deservedly attracted considerable attention on account of its very practical character. Of course it is quite impossible that a comprehensive treatise on water supply engineering could be compressed into the limits of a single newspaper or magazine article. What Mr. Gemmell has done is to place in plain array the practical points in construction whose neglect is sure to result in serious defects, if not practical or total failure. For an example of such failure arising from insufficient attention to the quality of puddle for reservoirs, an instance of failure to retain water in a new reservoir constructed for one of our large seaboard cities, and first filled during the past summer, might be cited—a failure that caused much disappointment, and loss to the contractor and delayed seriously a much needed addition of supply for the city alluded to.

Of clay puddle Mr. Gemmell says that "when properly made, it is nearly as valuable as concrete, but when carelessly made it may be worse than useless."

> The materials used should be carefully selected, properly proportioned, and thoroughly compacted. If the compacting is done by ramming the surface of each layer should be deeply scored to make bond with the succeeding layer; if by rolling, a heavy grooved roller should be used. In the whole process of the design and construction of a reservoir the engineer should bear in mind the fact that "water abhors an angle," and should lose no opportunity to put one in its way wherever it is likely to try to force a passage out. The utmost care must be used to prevent the water following along the pipes in the entry trench, by enclosing them in masonry and building cut-off walls across them at intervals. Water is the most subtle enemy with which an engineer has to deal, and every precaution known to man must be taken to prevent its working through the embankment—even then the work may result in partial failure.

The article deals also with the testing of pipes, hydrants, gates, etc,; the proper location of street mains, with reference to the buildings to be supplied; the proper way to set hydrants; the inspection of pipes to determine existing imperfections; the depth to which trenches for pipes should be excavated; the proper method for laying pipes; pipe joints; pipe fittings; stand pipes for hydrants; size of connecting pipes for fire hydrants; excavations for and the proper setting of hydrants, etc., thus going over a subject that, while familiar to all trained hydraulic engineers, is one upon which municipal officers often need the precise kind of practical information, expressed in clear language with avoidance of technicalities, that Mr. Gemmell has given in this article. Especially is what he says about reservoir construction of value to city officials who, not being engineers, still desire to be able to form some reasonable judgment of the quality of water supply construction independently of the opinions of experts. This is not to say that any official not trained to engineering would, by reading Mr. Gemmell's paper, be able to dispense with expert advice in judging of the good or bad points in construction or repairs; but, that its perusal would, in very many cases, supply a kind of knowledge which would be very much better than the blank ignorance of the subject possessed by most city officials who get into office under existing systems of municipal government. It would at least enable them to suspect faults which often are entirely overlooked, and to intelligently guide their inquiries through the aid of experts.

Electrolysis Affecting Water Mains.

Under the title Mr. G. H. Benzenberg, of Milwaukee, presented to the recent convention of the American Water Works Association at Minneapolis a paper of unusual importance dealing with the recently ascertained destructive effect upon water mains that has followed the practice of connecting wires with underground mains or hydrants. The paper has been printed under the heading, "The American Water Works Association" in *The Age of Steel;* and on account of its practical value has also been published and commented upon in many other engineering papers.

The true cause of the corrosion is found not to depend directly upon electric currents but to electrolysis of soluble salts existing in the earth surrounding the mains. The passage of the current through the mains sets up the decomposition of these salts—chlorides, nitrates, or sulphates of ammonia, soda, or potash, setting free their acids, which thereupon actively attack the iron pipes. A very interesting account of how his attention was first attracted to the subject through the bursting of a pipe in front of power house is given, but as this is not the most important part of the discussion, the reader is referred to the original paper for it.

The method of determining when and where the action is taking place, and its remedy, is, of course, what will be of greatest service to engineers. Mr. Benzenberg says "the water-works engineer can satisfy himself perfectly, whether his pipe is in danger or not, by purchasing a volt ammeter that will record a fiftieth part of a volt or ampere, and any of his men can, at the time they tap the main along the lines of a street railway, or occasionally with a hydrant, connect the same, one end with the water pipe and the other with the rail. If it indicates that the pipe is positive there is danger to the pipes.

"If the pipe shows it is negative to the rail there is no possible danger. The information can be easily and quickly obtained. It does not need an expert. A careful man, a tapper, or any one of the employés, except a common laborer, can keep on making these investigations and soon ascertain whether any part of the pipe is positive.

"As soon as it is indicated that the pipe is positive to the ground, further investigations should at once be made, first, as to whether the soil contains any of the soluble salts heretofore mentioned; and if it does, there is no question but what electrolysis is taking place and corrosion of the pipe is occurring at some point. There is no necessity of opening your trench to ascertain where this electrolysis is taking place; all it needs is to establish the proper equilibrium at that point between the pipe and the rail, by making a connection, with a good clamp and sufficient copper bond, between the pipe and the rail. At that point at least and for a long distance your pipe is immediately made negative and freed from all danger. It is surprising how quick the change takes place, and yet it is not surprising—because, as has been stated, the flow of the current is instantaneous; I have known where a tap had been made and the volt meter showed the pipe of five-tenths of a volt positive, sufficient to produce corrosion if the salts of the earth were of such a nature as to cause electrolytic action. A bond was placed around the pipe by my own man—keeping the volt ammeter in connection—and the moment the connection was made with the rail the pipe became negative."

Much other valuable information may be gained by a perusal of this excellent paper. For example the author does not advise the use of water mains as gronnd connections, yet he states that with proper precautions already indicated, 31 per cent. of the entire output of the power station at Minneapolis is returned through the water pipes without damage to the latter. The proper method of making the connection between the pipe and the rail to change the current from positive to negative is also described in detail. In dealing directly in the plainest possible manner with the subject in hand, and the avoidance of all superfluities, Mr. Benzenberg has supplied a model for engineering papers on practical subjects, which others may well imitate.

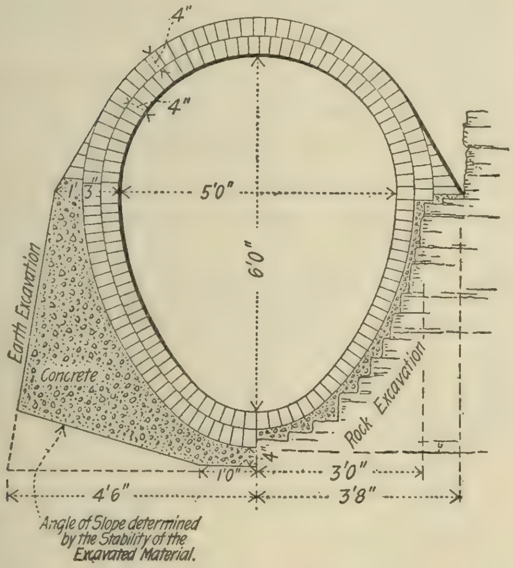
The West Side Trunk Sewer, Rochester, N. Y.

BECAUSE of some unusual features the sewer named in the title is attracting attention from engineering papers, and in *Engineering News*, an illustrated description of it is given. Our contemporary has kindly loaned the accompanying engravings for use in this review. Mr. Will. E.

Crane is the engineer in charge of the work.

The main trunk of the sewer, 17,700 feet in length, has lateral extensions aggregating 13,000 feet. The trunk sewer at the beginning is 5 feet in diameter (egg-shaped as shown by Figure 1) and increases to 6, 6¼, 8, 8½, 9 and 9¼ feet at the outlet. The minimum grade is 1 in 500 for about one-third of its length. The remaining length has its grades of 1 foot in 150 and 1 foot in 200. There are 1980 feet of 9½-feet tunnel. The sizes pass from egg-shaped to circular and thence to the horseshoe section. The outer shell is concrete rubble masonry to 1 foot above spring of arch, lined and arched with brick. The invert has one and two rings of brick imbedded in concrete to bed rock.

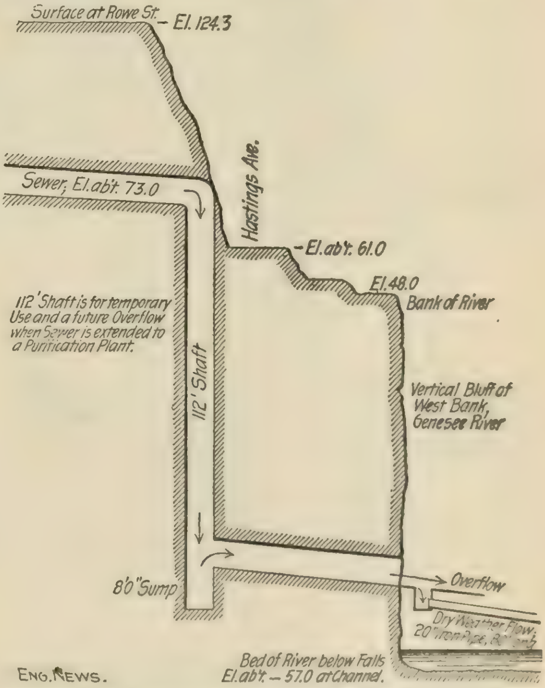
This one-sided rock excavation is one of the peculiarities of the work, and is made available to lessen the cost of the mason work lining, as well shown in figure. Of this feature the article under review speaks as follows:



This 4½ feet, egg-shaped portion of the lateral sewer (which sewer diminishes to 2½ feet in diameter) is designed to be similar in construction to that already described, with a two-ring brick arch and a two-ring invert when in earth, and one-ring invert in rock. The 5-feet section of the trunk sewer, has the same thickness of invert and arch. The 6¼ feet circular and egg-shaped sewer and all the larger sizes have concrete foundations, resting on 1-inch boards when not in rock. The 6¼ feet sewer has two rings of brick for the invert lining, and three rings for the arch, as do all the larger sewers, except when on a rock foundation or in tunnel. When on rock these larger sewers have but one ring of brick in the invert, except for one special section, where the rubble masonry is carried part way beneath the invert and the invert lining consists of but one ring of brick. In solid rock tunnel there is no lining except one ring of brick on the invert, resting on a thin layer of concrete.

"Two miles of the main trunk is in or through public highways," says *Engineering News*. "The remaining length passes through a deep ravine, whose banks are abruptly vertical to a height of 10 feet at the beginning to 98 feet at the junction with the Genesee river, into which the sewage is, at present to be discharged." Of the construction of the sewer in this ravine the following particulars are given:

"The fall is so great through the ravine, in places 1 foot in 23, that 5 drops, from 6 to 13 feet each have been designed and one shaft 112 feet deep." The drops are constructed with a curve, which is a parabola reversed in a circle to connect with the lower section. The 112-feet shaft is provided with an 8-feet sump, and is shown in section by the sketch below. There is only a temporary outlet to get to the river below the lower falls; provision is made to eventually extend the sewer to a point lower down the river and to a purification plant."

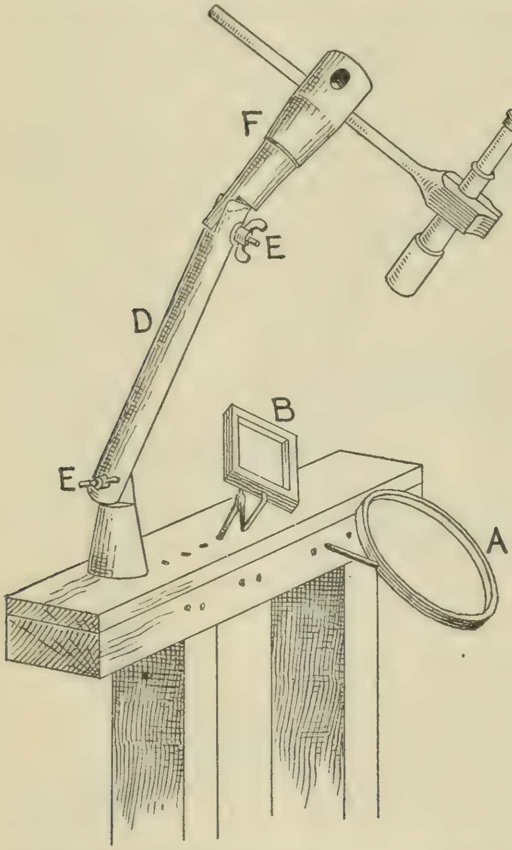

Surface at Rowe St. - El. 124.3
Sewer, El. ab't. 73.0
Hastings Ave.
- El. ab't. 61.0
El. 48.0
Bank of River
112' Shaft is for temporary Use and a future Overflow when Sewer is extended to a Purification Plant.
112' Shaft
Vertical Bluff of West Bank, Genesee River
8'0" Sump
Overflow
Dry Weather Flow, 20" Iron Pipe
Bed of River below Falls El. ab't. - 57.0 at Channel.
Eng. News.

Inspecting Interior of Pipe Sewers.

A SHORT illustrated article in *Engineering News* for September 27, describes a very useful instrument, by which the interior of a pipe sewer under construction may be quickly and accurately inspected. The publishers have kindly loaned the cut for use in this review.

It is simply a specialized form of the heliotrope. An assistant with a mirror about 8×12 inches in size, throws the sunlight upon the mirror A, which reflects it into the sewer, or upon any desired poiut. The image thus illuminated is observed through the telescope C, by the reflection in the small mirror B. The two supporting posts shown are no part of the heliotrope.

The apparatus consists of a stick of wood 2×3×20 inches in size, with numerous ¼ inch holes bored through it in both horizontal and inclined positions. Two mirrors mounted on wooden backs, one 6 inches in diameter and the other 2 inches square, are hinged or swung in Y-shaped frames, the branches being No. 6 wire and the stem ½ inch iron rods, 6 inches long. The wooden timber is laid across the sewer in the manhole, and the rods carrying the mirrors are inserted into the holes conveniently for reflecting the light into the sewer. The observer takes such a position that his back is toward the section of sewer under examination. The image which he thus sees in the mirror B, or in the telescope C, is erect and in its natural position.



The mounting of the telescope is by means of the post D, about 2 feet high, turning on a 1-inch pivot in the bottom. The post is jointed at right-angles at EE, and clamped in position by thumb nuts. It is also pivoted at F. A ½-inch hole is bored through the top of the post, in which turns and slips the ½-inch wooden rod with clamp holding the telescope.

The post can be set up at either end, or at the middle of the 2×2-inch timber, and the telescope, magnifying 10 diameters, can be readily given any position and pointing.

In inspecting sewers in course of construction the heliotrope is set transversely in front of the open pipe, in a similar position to that which which would be taken in the manhole.

The article was contributed by Walter C. Parmley, assistant city engineer of Peoria, Ill. This gentleman asserts that the use of this instrument has had a marked beneficial effect upon sewer construction. Not only were the men more careful in performance of their work when conscious that it would be clearly and fully inspected, but the employment of the device has very materially assisted construction by enabling workmen to obviate faults, the avoidance of which, in the absence of such aid, could only be a matter of surmise. Mr. Parmley, in speaking of the range of power of the device, says it is so ample that he has been able to examine "the inside of a whole block of 4-inch drain tile from one position, and the large sizes are still more easily observed."

The Philadelphia Asphalt Tests.

THE increase of the use of asphalt for the paving of city streets in the United States is notable. With reference to tests of the quality of this material which increasing use renders yearly more important, much information may be gained from a perusal of an article contributed to *Paving and Municipal Engineering* for October by Mr. Dolphus Torrey. Mr. Torrey states that he has worked for months, and has made two or three thousand tests of cohesive strength of asphalt, crude and refined, and also of asphalt cements and pavement mixtures. The reader will find in this article not, perhaps, what he might expect from this assertion—tabulated statements of results of these extensive experiments, but rather some conclusions from them which the author has been led to adopt provisionally.

A considerable part of the article is devoted to the effect maltha has upon asphalt. Mr. Torrey states "that, for several years, he was firm in the conviction that maltha would be a better material for tempering paving cements than the residual oil customarily used." He now believes that "the determining consideration is that of subsequent chemical stability of the compound," and that "until this determination can be made it will not be prudent to change the current practice." It will be noticed that the author writes of these materials as though chemical combination takes place when they are mixed together, and, indeed, he positively asserts this belief in the paragraph quoted below.

"Contrary to the generally accepted opinion, the author believes the oil does form a chemical union with the asphalt when the mixing is properly done. This being true, it follows that cements made by treatment which does not fully effect such chemical union will be imperfect ones, and tests made with them inconclusive as to the value of the materials. As to the quality of residuum oils used in the construction of any particular pavement, they should be the best obtainable in a commercial way; the distilling being conducted to produce a requisite quality, not an incidental by-product.'

Referring to a previous article contributed to the May number of the magazine quoted, Mr. Torrey recalls what was there said about a process for obtaining by solution four important fractions of an asphalt; and he believes that "the information gained by combining these in various proportions will prove of considerable help for the comparative valuation of asphalt." He concludes this excellent paper as follows:

> Assuming that changes of cohesive strength of an asphalt are indications of molecular changes in the material, the author has freed samples from insoluble materials, to obtain what may be called physically pure asphalt. This is combined with various percentages of oil, and the samples so made have been tested at several temperatures, to find what modifications of strength the oil effects. For each point of testing five tests are made, and an average result secured for record. The results admit of graphic representation, and thereby the most ready and comprehensive comparison. In like manner trial has been made of the influence which different percentages of stone dust effect in the way of cohesive strength of cements. These also admit of graphic representation and comparison. It is much too early, in the investigations being made, to venture any announcement of definite conclusions.

Mr. Torrey intimates that these important experiments will be continued and that the final conclusions will be given to the public in practical form. The materials he is thus collecting cannot fail to prove a valuable addition to previous knowledge regarding asphalt.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

24986. Some Experiences with a Gas Works in a Cold Climate. J. P. Gill (A G L J–Sept. 10.) 1900 w.

*25151. Experience with the Prepayment-Meter System. H. Wimhurst (G W–Sept. 8.) 4000 w.

25175. Experiences with Some Leaky Gasholder Tanks. Ill. J. Chadwick, with Discussion (A G L J–Sept. 17.) 4700 w.

*25203. Retort-House Construction. Ill. W. D. Child, with Discussion (J G L–Sept. 11.) 6400 w.

*25358. Gas from Sawdust (G W–Sept. 15.) 1000 w.

*25431. The Regulations for the Supply of Electricity Compared with Those for the Supply of Gas. Norton H. Humphrys (J G L–Sept. 18.) 3200 w.

*25666. The Production of Gas from Paraffine Oils. (Abstract) J. F. Tocher (J G L–Sept. 25.) 4200 w.

Sewerage.

24960. The Treatment of Sewage by Ferozone and Polarite. Arthur Bowes (E R–Sept. 8.) 1600 w.

25028.—$1.50. Chautauqua, N. Y., Sewage Disposal Works. Ill. William B. Landreth (T C E–July.) 2500 w.

25042. The West Side Trunk Sewer, Rochester, N. Y. Ill. (E N–Sept. 13.) 500 w.

*25134. The Super-Saturation of Sewage Farms. Editorial (Eng L–Sept. 7.) 1100 w.

*25268. The Salford Sewage Works (E-Sept. 14.) 1100 w.

*25273. A Question of Value.—Sewage Treatment. Editorial (Eng L-Sept. 14.) 1500 w.

25291. The Aramingo Canal Sewer, Philadelphia. Ill. (E R-Sept. 22.) 400 w.

†25359. Mr. Silk's Sanitary Tour.—The Sewerage of Berlin (I E-Aug. 25.) 1000 w.

25412. A Device for Inspecting the Interior of Pipe Sewers. Ill. Walter C. Parmley (E N-Sept. 27.) 500 w.

†25524. Sewage Disposal at Worcester, Mass. Harrison P. Eddy (J A C S-Oct.) 1500 w.

25580. The Sewerage and Water Supply Systems of Oberlin, O. (E R-Sept. 29.) 2500 w.

25624.—$1.50. The Sandrock Sewers of St. Paul, Minn. Ill. George L. Wilson (T C E-Aug.) 2500 w.

*25677. The Pollution of the Aire and Calder. Editorial (E-Sept. 28.) 1800 w.

*25684. Electrolytic Sanitation. Editorial (Eng L-Sept. 28.) 2200 w.

Streets and Pavements.

25034.—$1.50. On the Marking of Street Lines. C. M. Broomall, with Discussion (T C E-July.) 3000 w.

*25279. Street Paving in Sheffield (B A-Sept. 7.) 1800 w.

*25515. Specifications for Brick Pavements. J. A. Hall (P-Oct.) 2000 w.

*25517. Maltha as a Flux for Asphaltic Pavement. S. F. Peckham (P-Oct.) 1500 w.

Water Supply.

24959. The Water-Works of Remscheid, Germany. Ill. (E R-Sept. 8.) 1700 w.

25166. The Norwood, O., Water Tower. Ill. (E R-Sept. 15.) 3000 w.

25186. Water Supply Engineering (A S-Sept. 15.) 2300 w.

25187. The American Water Works Association (A S-Sept. 15.) 600 w.

25212. New Pumping Engines for the Chicago Water-Works (E N-Sept. 20.) 1000 w.

25298. The Water Supply of Jersey City. John W. Hill (F. W-Sept. 22.) 3200 w.

25389. Some Practical Points in Water Supply Engineering. R. C. Gemmell (Sc A S-Sept. 29.) 3500 w.

25503. The Lawrence Filter Bed. Ill. (F W-Sept. 29.) 800 w.

25504. Filtration. Ill. Joseph B. Rider (F W-Sept. 29.) 2800 w.

25505. Experiments with Tube Wells at Lowell, Mass. (F W-Sept. 29.) 4300 w.

25534.—75 cts. Electrolysis of Water Pipes. Charles A. Stone and Howard C. Forbes, with Discussion (J N E W-Sept.) 11000 w.

25535.—75 cts. The Filter and the Water Supply of the City of Lawrence and Its Results. Ill. Hiram F. Mill, with Discussion (J N E W-Sept.) 6600 w.

25536.—75 cts. Remarks Concerning a Recent Paper by L. M. Hastings, on the Flow of Water in a Compound Pipe. George A. Ellis, with Discussion (J N E W-Sept.) 3500 w.

25579. The Covered Reservoir at Rockford, Ill. Ill. (E R-Sept. 29) 1500 w.

25622.—$1.50. The Quality of Water Supplies. John W. Hill, with Discussion (T C E-Aug.) 16500 w.

25628. An Expert's Report on the Peoria Stand Pipe Failure (E N-Oct. 4.) 1100 w.

25632. Continuous and Intermittent Sand Filtration of Water. George W. Fuller (E N-Oct. 4.) 3000 w.

25635. Bacteriological Studies of the Toronto Water Supply. E. B. Shuttleworth (E N-Oct. 4.) 2800 w.

25714. The Nashville, Tenn., Water-Works. Ill. (E R-Oct. 6.) 1200 w.

Miscellany.

*24948. The Great Dam at Austin, Texas. Ill. Frank E. Snyder (E Mag-Nov.) 3000 w.

25176. The Prevention of Electrolysis (A G L J-Sept. 17.) 1000 w.

25191. The Element of Beauty in City Parks (G & F-Sept. 19.) 1600 w.

†25259. The Municipal Museums of Paris. Frederic Harrison (F R-Oct.) 4500 w.

25299. Progress of Electricity in Municipalities. Charles A. Rolfe (F W-Sept. 22.) 3000 w.

25413. The City Ownership of Street Railways (E N-Sept. 27.) 1300 w.

*25476. Betterment (A L-Sept. 21.) 3400 w.

*25516. Cincinnati's Municipal Purchasing Agency. Aug. Herrmann (P-Oct.) 900 w.

*25518. Municipal Ownership of Subways. C. H. Morse (P-Oct.) 800 w.

Serials.

18870. Humidity and Ventilation. The Effective Ventilation of large Public Buildings. Joseph Nasmith (A Ar-Began June 13, 1893—Ended Sept. 22, 1894—5 parts—15 cts. each).

21592. The Harlem River Speedway. Ill. (E R-Began April 28—9 parts to date—15 cts. each).

23641. Details of Rural Water Supply (B-Began July 7—13 parts to date—30 cts. each).

24751. The Gas Manager Abroad. F. W. Cross (G W-Began Aug. 25—5 parts to date—30 cts. each).

25117. Remarks on the Gas Industry in America. H. Bunte (P A-Began Sept. 15—2 parts to date—15 cts. each).

25179. The Water Service and Fire Protection of Theatres. William Paul Gerhard (F W-Began Sept. 15—4 parts to date—15 cts. each).

25202. Illuminating Power and Illuminating Effect. J. T. Sheard (J G L-Began Sept. 11—2 parts to date—30 cts. each).

25347. About Water Gas. Edwin A. Down (G E M-Began Sept 10—1 part to date—30 cts).

RAILROADING

A New Wool Test for Color Blindness.

A NEW test for color blindness, of the kind known as the "*wool* test," is practically discussed in an article printed in the *Railroad Gazette*. It is written by William Thomson, M. D., well known in connection with such tests. This new test is stated to be an improvement upon the "color-stick" and arrangements of wools adopted by the Pennsylvania Railroad Company in 1880, and has been devised after much study of the subject by the author of the paper under review.

The color-skeins of this new arrangement have been carefully selected, and a standard set will be kept, so that renewals may be made of the entire set of those skeins that may become faded, soiled or lost. The new set consists of a large green and a large rose test-skein, and forty small skeins, each marked with a bangle having a concealed number extending from 1 to 40, placed in a double box, so arranged as to keep the two series apart and to permit each to be exposed upon a table in a confused mass.

Those who desire to acquaint themselves with current methods of testing for color-blindness, and the extent to which they are used on railways, in the selection of signalmen, cannot afford to neglect the perusal of this excellent article. It is very difficult to quote from it any part which will give a good idea of the whole, on account of the intimate connection each has with the whole subject. What the author has to say about the use of the new test in examinations follows:

> The large green skein being placed near by, the small skeins from 1 to 20 are exposed in good daylight, and the employé under examination is directed to select ten shades of the same color of the text-skein. One with normal vision will choose promptly and with ease the ten greens with odd numbers on the bangles. A color-blind person will hesitate, and his selections will contain some even numbers, and the confusion-colors will be shades of brown, etc., containing some red or shades of gray, and will indicate the color-defect. These figures are to be recorded on a blank, and the twenty skeins are to be removed. The large rose skein is then used and the examination repeated in like manner with skeins numbered from 21 to 40, and the result recorded. The confusion-skeins which have even numbers are blue, green and gray. From the selections made by the man found color-defective by the green-test, we are able to decide the character of his color-blindness. Those selecting blue are red-blind; those taking greens and grays are green-blind, according to the nomenclature of Holmgren. There are ten roses and ten confusion-colors in the second series.
>
> The red test-skein of the stick, with its confusion-colors, is omitted entirely, and the test is made to conform more strictly with Holmgren's method, while the examiner is also provided with 40 questions of decisive clearness. Greater scientific accuracy is obtained by this method, and with the careful selection of these confusion-colors I now regard this system as an improvement upon the stick, and as a safer and more simple method to be used by a non-professional examiner.

Light Railways in England and France.

IT seems that the experiment of very light, narrow gage railways is again to be tried. Between 1860 and 1870, it will be recollected, narrow gages were strenuously advocated, and as urgently opposed, and, as it then appeared, upon such good grounds, that the narrow gage roads of the time only survived to be used temporarily in a small way, in carrying earth and broken rock from excavations and transportation of materials through short distances from points of delivery to parts of constructive work where needed. At least the reviewer does not now recall any instance of its survival for passenger or freight traffic, except in some mountainous regions where the exigencies of the case has compelled their use. The controversy at the time was generally spoken of by engineering publications as the "battle of the gages." There were, however, those who advocated even wider gages than the general standard now in use. A notable example was the New York and Erie Railway, which having adopted a wide gage subsequently abandoned it for the standard gage. Now the *Railway Times* tells us that an interesting exhibition has just been held at Duffield Bank, near Derby, England.

The primary object of the exhibition was to solve the various problems involved in the successful designing of engines, carriages, and roadway of the narrow gage. The chief ends in view were, first, the application of narrow gage lines to agricultural and commercial purposes, and, secondly, to the requirements of military transport in countries destitute of roads. The latter point some years ago engaged the attention of the Royal Engineers. The construction of this line of 15-inch gage was begun in 1874, and various additions were made up to 1881, when the length laid amounted to about a mile, inclusive of sidings. Since the latter date there has been no material extension, but the permanent way and its accessories have been improved. The line runs from the farm and workshops up a gradient, varying from 1 in 10 to 1 in 12, about a quarter of a mile long, to a level 80 feet above, where the experimental course is laid out in the shape of a figure 8, so as to admit of continuous runs. This part, somewhat more than half a mile in length, has a level stretch of a quarter of a mile, the remainder consisting of gradients of which 1 in 25 is the most severe. The maximum curve on the main line is of 25 feet radius, but in the sidings some occur which are as sharp as 15 feet radius.

It therefore appears that the narrow gage is up again for reconsideration, and this is further apparent from the fact that for two years a line of 2 feet gage has been in operation in the department of Loiret, France. Very full particulars of the permanent way, etc., in the Derbyshire experiment are given. The gage of this miniature railway, as has been said, is only 15 inches, and its length is about one mile. The account of the entire outfit is given, and is full of interesting particulars. It is said that the Royal Engineers have been inspecting the locomotives used, with a view to adopting the plan on the military railway at Chatham.

The length of the French line spoken of is 22 kilometers. It is used for both freight and passengers, and is laid right along the side of the public highway, so that farmers (this a beet-root district) can lay temporary sidings, and run their loaded cars out to the main track. Herein a proper and advantageous function of the narrow gage railway seems to have been discovered; and if such a road has any prospect of being profitable, as is hoped, in France where the roadways are probably as good as can be found anywhere in the world, there would seem to be many places in the United States (in which the highways are notoriously bad) where the system might be profitably introduced.

The Cowlairs Incline.

POSITIVELY one of the most interesting articles of a descriptive character relating to railroads that has reached the reviewer's table, during the current month, is that indexed under the title, "The Cowlairs Incline on the North British Railway."

This article, written by M. A. Lockyer, and magnificently illustrated from photographs taken by Mr. Lockyer himself, is printed in *The Railway World* (London) for October. Nothing finer in the way of illustration than the pictures of special features of this famous railway incline have ever appeared in any publication devoted to railroading; and the description will be read with interest by railroad men even though they chance to be familiar with the peculiarities described.

The illustrations are a view of the exterior of the engine-house at the top of Cowlairs Incline; the main driving pulley, in two sections, ready for putting in place; interior of the engine-house; "messenger" affixed to locomotive at foot of the incline; men splicing the cable (which is entirely a different matter from, and must not be confounded with, what sailors call "splicing the mainbrace"); brakesman removing "messenger" from rope; train descending incline to Queen street, Glasgow, in charge of brakemen; train and brake vans at top of Cowlairs Incline, and West Highland train ascending incline to Cowlairs station.

These illustrations are all immediately pertinent to the descriptive text, and hence their mere enumeration will convey a good idea of the article when it is added that the description is not made to fit a set of illustrations as is frequently the case in this kind of article, but the illustrations are entirely subordinated to the demands of the subject. The introductory paragraph introduces the reader at once to an interesting fact, as follows:

> It scarcely seems credible that, notwithstanding the enormous increase of traffic and the use of heavier rolling stock generally, machinery put down in the beginning of the year 1842 and continually working, should still be in good repair and full working order; and yet such is the case with the haulage plant at Cowlairs, which both on account of its age and history deserves attention. The incline, which lies between Cowlairs and Queen Street terminal station, Glasgow, commences at the entrance to the tunnel and terminates at Cowlairs station, where the haulage engine and consequently the main part of the gearing are situated. It is a mile and a half in length, having a gradient of 1 in 42, the lower half being under tunnel.

The order of treatment then proceeds with a description of the engine-house (architecturally noteworthy) with its engines and appliances; the incline and rope (or cable as we should call it in the United States) and, lastly the method of working. As the article fills something over 5 large quarto pages, only one or two of the interesting details described in it can be brought under review, as fair samples of its general interest and value.

A bit of characteristic description is quoted in the following paragraph:

> "In 1844 the engine was stopped altogether, the company thinking that perhaps locomotives would serve the purpose better. Four powerful engines were accordingly built; two (Samson and Hercules), at Cowlairs Works, and the remainder (Millar and Hawthorne), at Newcastle, causing at the time considerable excitement. But this expedient proved a failure, although by this it is not necessarily meant that the engines could not do the work, which was, however, sometimes the case; but the exhaust steam kept injuring the tunnel, while the engines when wanted at Queen street were often at Cowlairs, and vice versa. The stationary engine was accordingly once more put into working order, and it was at this period that the cylinders were increased in diameter, and the haulage-rope, instead of being made of hemp as formerly, was constructed of iron-wire, the rope being supplied to the company by a Newcastle firm, R. S. Newall & Company, famed for their untwisted wire-rope. The engine was finished by the 4th of March, 1847, and on trial under the new conditions of haulage proved highly satisfactory; so much so that the four locomotives were removed altogether, and the locomotive superintendent at that time, Mr. Paton, and others concerned, gave up the idea completely, nor has it again been tried."

As in the paragraph quoted so in other parts of the article practical information is so happily combined with description, as to fully justify hearty commendation.

Many American readers will wish to know what is the technical meaning of the word "messenger" several times alluded to in the subjects of the pictures above named. Even this bit of information, which a careless writer would have probably overlooked is given. The author defines it as "a name given to the chain which connects the train engine to the rope, the unsatisfactory working of which was one of the reasons for trying the experiment of substituting locomotives for cable traction above narrated. In wet weather it slipped on the hauling rope; but after the substitution of wire rope for the hemp rope previously used was made, the author says that it operated satisfactorily.

Notes on German Railroad Practice.

UNDER this title Mr. E. M. Herr contributes the last of an instructive and entertaining series of articles to *The Railroad Gazette*, dealing with the construction, maintenance of way, general statistics and statistics of traffic of German railroads, with other interesting particulars concerning them. He concludes the article with an allusion to "the careful, systematic, and thorough study which German railroad engineers and managers have made in recent years of the business of railroading in all countries, but more especially in the United States." He says: "One sees everywhere substantial evidence of the completeness of their investigations into American practice, and of the care and skill with which they are adapting to their use the American methods and devices best suited to the needs of their service."

He calls attention to the fact that German railroads were not built, like most American roads, for the purpose of developing a new country; they were, on the contrary, intended "to accommodate an already dense population." They were accordingly much better constructed than were most American roads at the start. At the expense of heavy and expensive construction work, "serious grades and sharp curves were avoided." Such expensive construction has been deferred in the United States until increase of traffic promised earnings that would warrant investments of additional capital. The author states that in the German railroads "the subway, comprising all embankments, cuts, bridges, culverts, foundations, retaining walls, etc., is well constructed and cared for. Ballast is spoken of as "very ample on the principal lines, and rather deficient on important branches." Of wood ties the author says their increasing price is leading to a more extensive use of steel ties. In 1892, nearly 20 per cent. of all ties used on these roads were metal. Wood ties are almost universally treated with zinc chloride as a preservative. "The average cost of wood ties during the year 1892, on all German lines, was $1.14 each, while the cost of metal ties weighing 109 pounds each during the same year was $1.70." Rails of T-section are mostly used, averaging a little over 67 pounds per yard.

The average cost of maintenance and repairs to track, roadbed, stations, yards, signals, telegraph, and all other parts of the permanent way, and buildings, including bridges, tunnels, workmen's houses, coal sheds and chutes, was during the year 1892, per mile of line, $1.575; ditto per mile of track, $916; ditto per 1000 locomotive miles, $122.17; ditto per 100 car-axle miles (all kinds), $4.84.

Those who are urging state ownership of railways in the United States will find an argument in support of their views in the fact stated by the author, that 90 per cent. of all German railroads is absolutely owned and run by the German government. Mr. Herr says "the management is careful, conservative, and in general serves well the needs and requirements of the people."

German passenger traffic is divided into four classes besides the military, each of which has a special tariff, is handled in different cars, or at least in different parts of the same car, and is accounted for separately from the others.

This practice differing from that of any American line, the author gives in this connection, as of interest for comparison, a tabulated analysis of the German passenger traffic for the year 1891-92, for which those who desire details must consult the article itself. Tables of other interesting statistics, including classification and lengths of German roads in miles, comparison of equipment and traffic of the United States with the German, a similar comparison of average general and operating expenses, etc., are supplied, thus rounding up and completing an excellent series of articles.

Railways of the United States.

THE *Safety Valve* gives a comprehensive summary of facts relating to the railways of the United States compiled from the sixth annual report of the Interstate Commerce Commission. The statistics given in this summary are in convenient form for reference, and will be useful for this purpose to railway men, and also to the general reader, in connection with the current debate on the relations of the state and general governments to railways and railway corporations as a factor in the industrial disturbances which have recently agitated the country. The summary, even in its condensed form, being too long for transcription here, only general features can be indicated. It gives the number of employés in service on June 30, 1893, and the distribution of this service in various departments; the aggregate value of railway property, and the value represented in different investments and securities, together with the total indebtedness and the classified indebtedness; the total amount of stock paying no dividends, and of different securities paying no interest; total business of the roads, with totals of classified traffic, passengers, etc.; gross earnings; operating expenses; net income available for dividends; number of railway employés killed during the year ending June 30, 1893; number of passengers killed, etc.

One of the most striking things in the report is the railroad stock which pays no dividends. A movement toward securing uniformity in railway accounting, and the neeessity of a more complete compilation of freight statistics are mentioned; and *The Safety Valve* says "it is probable that something akin to a clearing house of freight statistics will become a necessity in the near future."

Light Railways.

IN another place in this Department something has been said upon the revival of interest in light railways as feeders of traffic for main lines. The interest in the subject now manifested in English railway circles seems to be decidedly increasing. *Transport* (Sept. 28) prints an unsigned leading article upon the subject broadly reviewing the opinions expressed by several prominent railway men at a recent meeting of the great North Scotland Railway Company.

The article states that the present revival of interest in the subject has been initiated by the necessity for something to help farmers in these days of depression and keen competition, by providing them with facilities for getting their produce cheaply to market. The matter has been discussed in a desultory fashion at the half-yearly meetings of a number of other English railway companies, and it has engaged the attention of newspaper writers, engineers and railway experts.

The principal obstacle to progress in experimental light railway lines for agricultural districts in the United Kingdom are the rules of the board of trade. This point was made prominent in the speech of Mr. Ferguson, at the meeting of the Scotland Railway Company above named. Upon this part of Mr. Ferguson's remarks the article reviewed makes the following comment.

> The most significant part of Mr. Ferguson's speech, however, was his reference to the requirements of the board of trade, which. as has been frequently pointed out by *Transport*, have proved an insuperable barrier to an extension of railway enterprise in this direction. It does certainly seem ridiculous that in an outlandish part of Aberdeenshire, where a railway is urgently needed to convey the produce of a scattered agricultural population to the nearest remunerative market, the line should be equal, in all its essential features, to the London and North-Western system between the metropolis and Carlisle. It is certainly to be hoped that parliament will next season, pass such a measure as will provide for a substantial relaxation of the board of trade regulations in regard to signalling stations and other matters, and thus simplify the efforts of those who are promoting industrial development by this means.

Many practical points relating to the construction and operation of this kind of railway, as exemplified in Wurtemburg, Saxony, and in France, where they have been in operation long enough to afford precedents, are stated in this well written and well considered article. Speaking of the light railway between Pithiviers and Toury in France, intended to accommodate the beet-root industry of the region, the author says:

> Important branches have been laid down by cultivators and manufacturers, and it is pointed out that an important feature in connection with this type of line is the facility with which branches can be laid and worked, as the gathering of the crops may require. The line is not materially different from many others which have been built on the continent, but it is an object lesson to those who look with disfavor upon the laying of such railways in this country. At all events I commend it to the attention of the Aberdeenshire people, who have begun to see the benefits which light railways would give to that important agricultural county.

The breadth of view and the evident familiarity with all aspects of the subject which characterize the article will commend it to progressive railroad men. There is undoubtedly a field for this kind of railways now opening, and the future looks promising.

A LOCOMOTIVE Tire Wear Indicator is described in the *Railway Gazette* (Sept. 14) with illustrations of its construction, and detail of the manner of using the instrument. The results of its use have, in the opinion of the paper quoted, settled conclusively some questions as to causes and peculiarities of tire wear, that were long a puzzle to railway men. Among these peculiarities is the fact that on locomotives running alternately backward and forward the wear is more uniform than on those which nearly always run in one direction. The angular position of the wear, as referred to that of the crank-pin, also presents marked peculiarities on locomotives used for different kinds of service. The article, though a short one, contains valuable information upon an important subject. For example, a locomotive used in heavy fast passenger service on a hilly division showed a slight amount of wear on the tire of the left front driver, just forward of a point in line with the crank-pin of the right-hand driver or about seventy degrees back of the left crank-pin. A locomotive of the same class used in local passenger service, showed at the same point a much greater wear, and at corresponding points on the other drivers, a somewhat less but perceptible irregularity. A four-wheeled switching locomotive showed a maximum wear on all drivers at a point about thirty degrees back of the position of the right-hand crank-pins, the wear extending, however, in each direction for nearly the whole circumference of the drivers.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24306. La Guaira and Caracas Railway. E. H. A. Heinke (R P L–Aug.) 1500 w.

24975. A Survey of the Railway Situation. Extract from Address of M. E. Ingalls. (R R–Sept. 8.) 2000 w.

24977. The Transportation Exhibit at the World's Columbian Exposition. James Dredge, with Editorial (R R–Sept. 8.) 2200 w.

24978. Freight Locomotives in Germany and England (R R–Sept. 8.) 1000 w.

*25019. The South Eastern Railway. Ill. (R W–Sept.) 2400 w.

25033.—$1.50. Brofford's Ridge Tunnel. Ill. Charles W. Staniford, with Discussion (T C E–July.) 3000 w.

25046. Changing the Gage of a Southern Mineral Railway. Hunter McDonald (E N–Sept. 13.) 1100 w.

25048. Cuban Railroads (R G–Sept. 14.) 2000 w.

25049. A Locomotive Tire Wear Indicator. Ill. (R G–Sept. 14.) 600 w.

25050. A New Wool Test for Color Blindness. William Thomson (R G–Sept. 14.) 1400 w.

25072. Types of Side Framing for Passenger Cars. Ill. (R C J–Sept.) 3000 w.

25073. Early Railroad Cars. Ill. (R C J–Sept.) 3500 w.

*25126. Railway Development in the South Yorkshire Coalfield (E–Sept. 7.) 1500 w.

*25132. Great Northern Railway.—Reconstruction of a Bridge over the Don. Ill. (Eng L–Sept. 7.) 600 w.

*25138. Manitou and Pike's Peak Railway. Ill. Thomas F. Richardson (J A E S–Aug.) 6200 w.

*25152. New Zealand Railway Policy (Tr–Sept. 7.) 3000 w.

*25154. A British Railway Question in Asia Minor (Tr–Sept. 7.) 1300 w.

25182. Standard Track Tools (R R–Sept. 15.) 600 w.

25184. What Are the Best Means of Saving Coal and Increasing or Holding the Mileage per Ton to a Desirable Figure ? (R R–Sept. 15.) 1200 w

25185. Judicious Interlocking. Editorial (R R–Sept. 15.) 1200 w.

25190. What Is the Proper Basis for Freight Rates ? Statements of J. W. Midgeley and M. C. Markham (R A–Sept. 14.) 1600 w.

25215. The Hall Signal System of the D. L. and W. R. R. and D. and H. R. R. Ill. (E N–Sept. 20.) 900 w.

25218. An Ancient Locomotive. Ill. W. F. Durfee (Sc A–Sept. 22.) 700 w.

25244. Compressed Air in a Railroad Shop. Ill. W. B. Ruggles (M A–Sept.) 800 w.

25250. Notes on German Railroad Practice. Construction, Maintenance of Way, General and Traffic Statistics. E. M. Herr (R G–Sept. 21.) 1000 w.

25252. The Proposed Standard Specifications for Locomotive Boiler Steel. Editorial (R G–Sept. 21.) 3000 w.

We supply copies of these articles. See introductory.

*25255. Railroad Travel in England and America. Ill. H. G. Prout (Sc M–Oct.) 20000 w.

*25260. Light Railways in England and France (Ry T–Sept. 15.) 1600 w.

*25262. Railways in China (Ry T–Sept. 15.) 1200 w.

25296. The Seniority Rule.—Its Disadvantages to the Trainmen and the Railways. C. H. Dascombe (R A–Sept. 21.) 1000 w.

*25307. The New South Wales Railways (Tr–Sept. 14.) 2500 w.

*25324. The Railways of Australia (B T J–Sept.) 2200 w.

*25369. The Electric Locomotive of To-Day.—An Interview with M. Bunau-Varilla. Ill. (M–Sept. 15.) 1200 w.

25375. The Basis of Transportation Rates. (R R–Sept. 22.) 2100 w.

25382. Train Motion and Resistance. R. E. Horton (A M–Sept. 27.) 1600 w.

*25400. Can Railroad Rates Be Cheapened? Harry T. Newcomb (F–Oct.) 3000 w.

25404. Artillery in the Locomotive Repair Shops. Ill. (R G–Sept. 28.) 400 w.

25406. Some Economic Features of Locomotive Evolution. Editorial (R G–Sept. 28.) 2200 w.

25407. Ventilation for Passenger Cars. Editorial (R G–Sept. 28.) 1500 w.

25408. The Evolution of the Railroad Club. Editorial (R G–Sept. 28.) 1200 w.

*25456. Notes on Steel Sleepers. W. H. Cole (I & I–Sept. 21.) 1200 w.

*25468. The Argentine Railways (Tr–Sept. 21.) 500 w.

*25489. Development of Railroads in the United States. Ill. Brandt Mansfield (Ch-Oct.) 3000 w.

25510. Car Doors and Fastenings. J. J. Frey (R R–Sept 29.) 1200 w.

†25547. Rebuilding the Pennsylvania Railroad after the June Flood of 1889. Joseph T. Richards, with Discussion (P E C P–April-June.) 6600 w.

25562. The Lubrication of Locomotives (Eng–Sept. 29.) 2000 w.

25588. Government Ownership of Railways. Where It Is Being Tried (R A–Sept. 28.) 800 w.

*25596. Interchange of Cars in Europe. A. S. (L E–Oct.) 1000 w.

25623—$1.50. Tequixquiac Tunnel, Valley of Mexico. Ill. Albert Johnstone Campbell and Frederick William Abbot (T C E–Aug.) 9000 w.

25630. How Can Present Methods of Rating Train Loads Be Improved. W. W. Wheatley (E N–Oct. 4.) 3000 w.

25637. C. P. Huntington's Views.—An Exhaustive Opinion on the Benefit of Railway Combinations (M R–Oct. 5.) 900 w.

25645. The Safest Place in a Railroad Train. H. G. Prout (A An–Oct.) 1500 w.

25646. The Production and Consumption of Steel Rails. J. Stephen Jeans (R G–Oct. 5.) 1700 w.

25647. New Passenger Station at Syracuse. Ill. (R G–Oct. 5.) 400 w.

25649. The New York Central Report (R G–Oct. 5.) 1800 w.

*25678. Self-Contained Electrical Locomotives (Heilmann's System). C. S. Du Riche Preller (E–Sept. 28.) 800 w.

*25681. Colonial Locomotives (Eng L–Sept. 28.) 4200 w.

*25746. The Light Railways Question (Tr–Sept. 28.) 1800 w.

*25750. The Relation of Railroad Transportation to Production in California. R. L. Dunn (I S F–Oct.) 5600 w.

*25825. The Cowlairs Incline on the North British Railway. Ill. A. E. Lockyer (R W–Oct.) 2000 w.

Serials.

15496. Railroad Copper-Smithing. Ill. John Fuller, Sr. (L E–Began Sept. 1893—11 parts to date—30 cts. each).

17826. Evolution of the Air-Brake. Ill. Paul Synnestvedt (R E M–Began Dec.—10 parts to date—15 cts. each).

23719. The Early Railway Routes to Scotland. G. A. Sekon (R P–Began July—3 parts to date—30 cts. each).

23887. The West Highland Railway. Ill. (E–Began July 20—Ended Sept. 28—6 parts—30 cts. each).

24477. A Historical Sketch of Railroad Signals. Ill. Arthur H. Johnson (R G–Began Aug. 17—Ended Oct. 5—3 parts—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R–Began Aug. 25—5 parts to date—15 cts. each).

24660. The Compounding of Locomotives. A. H. Tyler (E Rev–Began Aug.—Ended Sept.—2 parts—30 cts. each).

24741. The Relative Efficiency of Air Compressors and Locomotive Air Brake Pumps for Shop Use (R E M–Began Sept.—2 parts to date—15 cts. each).

24809. Car Shop Economy. James F. Hobart (I C B–Began Sept.—2 parts to date—30 cts. each).

24817. Recent Turn-table Practice. Ill. R.) R–Began Sept. 1– 4 parts to date—15 cts. each).

24896. The Conversion of Metre Gauge to Indian Standard (5′ 6″) Gauge on the Bengal-Nagpur Railway. Ill. G. Moyle (I E–Began Aug. 14—4 parts to date—45 cts. each).

24938. Passenger Train Service in 1894 (Tr–Began Aug. 31—3 parts to date—30 cts. each).

25663. The Mushkaf-Bolan State Railway (I E–Began Sept. 1—1 part to date—45 cts).

25670. Special Shop Tools. Ill. (R E M–Began Oct.—1 part to date—15 cts).

25674. The New Central Railway Station at Lisbon. Ill. (E–Began Sept. 28—1 part to date—30 cts).

STREET RAILWAYS

Street Car Fenders.

"SOME time ago," says the *Railroad Gazette*, "a commission was formed in Baltimore, Md., consisting of the Mayor, City Register, and City Commissioner, for the purpose of considering the subject of life guards for trolley cars. The paper quoted (issue of Sept. 21) gives in an article of something over two columns the substance of the report made by the expert employed by this commission. The commission obtained the assistance of Mr. Cohen, Past President of the American Society of Civil Engineers; and as the investigation included critical examination of seventy different types of fenders, his report contains valuable information to all interested either in trolley or cable railways. The report of Mr. Cohen, begins with the ordinary cow catcher; and the fact that in tracing up the various inventions in this line, he found as many as seventy different ones shows well the importance that has attached to the subject. It is not proposed in this brief review to deal with each of the fenders named in the report. The general principles laid down, and the requirements for a good street-car fender, as stated by Mr. Cohen, are, however, worthy of more than a passing notice. If all inventors of this class of devices had possessed as clear a comprehension of these requirements as Mr. Cohen displays, there would have been much less wasted effort in attempts to supply what is essential. Mr. Cohen says, "what is needed is a very simple piece of work, the more simple the better."

It is required that the front surface of the car, striking a human being, shall be so arranged as to afford a reasonable prospect of saving the person from being dashed to the ground; and further so arranged, that it shall do the least possible damage by its own impact; and further, if it fails to do the duty expected of it, and the person does fall to the ground, or is already lying there, that it shall be devised so as to pass over him without causing further injury; and that there shall also be on each car a suitably arranged guard, preferably of angulai or "pilot" form, which shall be automatically brought in close contact with the street and rails, in order to prevent the crushing of the victim, whom the front device has failed to save.

Mr. Cohen found only two fenders that he recommended to the commission. But he says "neither of these came fully up to the requirements, though each contain good and valuable features." If this report be accepted as conclusive, the ideal street car fender has not yet been produced. Mr. Cohen decisively condemns all fenders the object of which is to scoop up persons either standing or falling, "but which make no provision for the contingency of failure to pick up the victims." He regards with favor only such as failing to pick up the victim will not by their form cause injury by passing over him. Of the latter five were found which are thought capable of doing good and effective service. All of these comprise both a fender and wheel guards. Some of the fenders in use are said to have fatal objections. One of these used in Boston is stated to have been recently condemned in that city, and the same fender used on several street railway lines in Brooklyn has struck and killed several children. The report, coming from so prominent an engineer as Mr. Cohen, will, doubtless, do much toward correcting erroneous opinions as to the efficacy of fenders offered to street railway companies by sanguine inventors.

Comparative Efficiency of Electric and Cable Tramways.

MR. FRANK B. LEA, in discussing this question in the London *Electrical Engineer* (September 14), maintains that in respect to economy and efficiency of working there is not much choice between the cable and the electric system, and that each method should be used in its proper field, having reference to the conditions under which the line has to be worked. From tests published not long since in the *Railroad Gazette*, he finds that the constant loss from the friction of the cable and machinery in four different plants ran from 16.48 per cent. to 20.82 per cent. Without citing any authority, he states that the average efficiency of an electric system may be fairly taken at 78 per cent., or a loss of 22 per cent. of the power at the dynamo-terminals. This would seem to be a very superficial view of the subject. The only adequate criterion is the cost per car-mile, worked out for at least a full year, between such a cable plant as that on Broadway, New York, and an electrically operated line of equivalent capacity, or nearly enough so to render the comparison a fair one, such for instance as some one of the lines now in operation in Brooklyn and Philadelphia. In the case of a light or irregular traffic, there is not much doubt as to the superior economy of the electric system, but whether the cable system on Broadway, for instance, could be replaced by an electric system which would do the same work more economically, is a problem which has as yet by no means received a final and conclusive solution.

Economy in Electric Power Stations.

OWING no doubt in some measure to the financial stringency of the past two or three years, an unusual amount of attention has been given by thoughtful station-managers to the question of economy in the production of electrical energy. It is difficult to say anything actually new on this well-worn subject, but it is nevertheless a matter which will bear a great amount of discussion without disadvantage to anybody. Mr. J. B. Craven, in a paper read before the New York Street Railway Association, and printed in the *Street Railway Gazette* (September 22), dwells particularly upon the importance of looking after the boilers. "No greater mistake"—he says—"is made than to place the care of boilers in incompetent hands, for they require the highest degree of care, conscientiousness and constant attention." The fireman is the man who shovels dollars under the boiler, and a thoroughly good man may save many times the amount of his apparently high wages. Mr. Craven advocates the use of direct connected plants, and insists throughout upon the absolute necessity of employing competent men, and paying them what they are worth. After all, this is the alpha and omega of economy, in electric power-stations or anywhere else. Nothing is more expensive than ignorance, and in no known place has ignorance proved to be more expensive than in or about an electric-light or power-plant.

Street Regulations.

A TIMELY article upon a subject that demands immediate attention has been contributed by Mr. Albert Weimer to the Philadelphia *Public Ledger*, and reprinted in the *Street Railway Gazette*. Mr. Weimer calls attention to the necessity of legislation to define the duties of the various classes of persons who use the streets, under the changed conditions imposed by the "simultaneous introduction of electric cars and bicycles." He suggests that the rule that persons and vehicles should keep to the right, should now be made imperative. "If it were well understood by everybody that this rule will be enforced under penalty," both pedestrians and drivers could rely upon certainty in the action of others, and accidents would be avoided."

The rule of some companies requiring cars to come to a full stop on the near side of streets to be crossed is spoken of as materially lessening the efficiency of roads where this rule has been adopted; and it is "so irregularly carried out that it leads to great uncertainty and confusion in the minds of pedestrians and drivers, and many resulting accidents."

"A complete circuit was made on the Tenth and Eleventh street line (Philadelphia), and it was found that the car made 35 full stops on the near side of the street crossed, while it crossed 152 streets without making any stop at all. On the Twelfth and Sixteenth street line two full circuits were made. On the first the car made 88 full stops on the near side of the streets, and passed 112 streets without stopping at all. On the second circuit the car made 93 full stops, and passed 107 streets without stopping. In these observations only streets were noticed which were of a width to allow at least two wagons to pass each other. It will be seen by the above figures that there must be a great uncertainty in the public mind as to what are the streets at which stops are made, and what streets are passed without stopping at all. This confusion is further increased by the fact that some of the companies do not require any stop at all, except when passengers are taken up or let off. Another serious objection to the 'near side' rule is that during the winter, when the streets are obstructed with snow and ice, passengers will have great difficulty in getting on or alighting from the cars.

"It seems to the present writer that, if the limit of speed of electric cars was somewhat reduced, and all cars are required to slow down when approaching streets which are much traveled or upon which street railways are operated, our new system of railways would be much more efficient in securing us rapid transit, and that many elements of danger would be eliminated."

The remainder of the articles comprises a proposed new code of street regulations, which have evidently been very carefully thought out, and which, if not all approved, cannot fail to prove suggestive upon an increasingly important subject.

Graphic Records of Street-Railway Statistics.

In the operation of electric power-plants, and more particularly in the case of street-railway plants in which the readings of consumption meters are unavailable as a check on the output of the power-station, it is too often the case that the profits of the enterprise escape through numerous unsuspected leakages, not individually large, but large enough in the aggregate to make all the difference between financial success and financial failure. The modern electric plant is so well systematized that it is not at all difficult to collect the necessary data bearing upon the different items of cost of operation, yet if, as is often the case, the significance of these data is permitted to lie buried in the records, very little is gained by the mere fact of their existence. In the *Street Railway Journal* (October) Russell Robb gives instructive examples of graphical charts, compiled from the results of the actual operation of a street-railroad, and explains their interpretation. The diagram sheet for the weekly record is ruled vertically for days, with a heavier line marking the divisions of the week, while the horizontal lines are provided with a set of marginal scales indicating "passengers carried," "car-miles run," "kilowatt hours," output of station and "pounds of coal" consumed. These scales are so proportioned to each other as to bring the curves conveniently near each other upon the diagram for comparison. Of course, there is nothing new in all this, but the full significance of such curves is not always appreciated as it should be. For example, if the coal line approaches more and more the kilowatt-hour line, it is evident that the efficiency of the plant for some reason is falling off. The character of the curve may indicate the nature of the trouble; as for example, an abrupt change in its direction coincident with the substitution of a different kind of coal, would indicate that the difference was due to the quality of the fuel. So also, the approach of the kilowatt-hour curve to the car-mile curve would indicate some change in the conditions outside the station. If this were due to an increase in traffic, the evidence of the fact would be found in the relative positions of the car-mile and passenger curves. A decrease in the efficiency of the car-motors, or an increase in the losses on the line would be shown by a gradual approach of the curves. With such a chart in the superintendent's office, kept carefully up to date, it would scarcely be possible for serious depreciation to go on without calling attention by striking and immediate evidence to the true state of affairs.

The magnificent mammoth souvenir of *The Street Railway Journal* celebrating its tenth anniversary contains 122 large quarto pages of reading matter plus 92 pages of advertising exclusive of cover. A large part of this space is occupied with matter pertaining to the annual convention of the American Street Railway Association, accompanied by portraits and brief personal sketches of the men who are most prominent in the organization. Other articles describing the city of Atlanta and other southern cities, with a catalogue of the exhibits, a list of applicants for space and the amount of space awarded to each, the leading articles all handsomely illustrated (there are over 400 of these illustrations), make this one of the most remarkable numbers ever issued in the history of trade journalism.

A history of street railways is another feature of this souvenir number that ought not to be missed in these reviews, but justice cannot be done to it in the space here afforded. In an elegantly illustrated article of 14,000 words the writer has presented a more comprehensive epitome of the origin and progress of the great street railway industry than has been put in print in any serial publication. The first street railway car ever built is illustrated, and from this to the modern street car and the electro-motor of to-day a great many rapid steps are reviewed.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

24989. Multiple Fuse Arresters. Ill. C. S. Van Nuis (S R G–Sept. 8.) 1300 w.

*25018. Tramway Rails Welded by Electricity. Ill. (R W–Sept.) 1400 w.

*25020. Isle of Man Electric Tramways. Ill. (R W–Sept.) 2000 w.

*25021. London United Tramways, Limited. Ill. (R W–Sept.) 1800 w.

†25060. The Electric Brake in Practice. Ill. Elmer A. Sperry (T A I E E–Aug. and Sept.) 6500 w.

*25097. Mechanical Traction for Tramways. Editorial (P Eng–Sept. 7.) 1500 w.

25169. The Series Method as a Remedy for Electrolysis. Nelson W. Perry (S R G–Sept. 15.) 2400 w.

25217. Recent Improvements in Cable Traction. G. W. McNulty (E N–Sept. 20.) 5000 w.

25249. Combined Curb and Conduit System. Ill. Gustave Monrath (W E–Sept. 22.) 800 w.

25251. Street Car Fenders (R G–Sept. 21.) 1600 w.

25288. Economy of Power House Operation. J. B. Craven (S R G–Sept. 22.) 2700 w.

*25349. Comparative Efficiency of Electric and Cable Tramways. Frank B. Lea (E E L–Sept. 14.) 1200 w.

*25352. The Economical Aspects of Electric Traction. Editorial (E R L–Sept. 14.) 1600 w.

25372. Underground Trolley for Street Cars. (S R E N–Sept.) 1100 w.

†25492. Electric Railway Construction in Philadelphia. Ill. (S R J–Oct.) 4000 w.

†25493. The Paterson, Passaic and Rutherford Electric Railway Company. Ill. Lemuel William Serrell (S R J–Oct.) 1100 w.

†25494. Graphical Records of Street Railway Statistics. Russell Robb (S R J–Oct.) 900 w.

†25497. The Perfection of the Electric Railway Motor. Lincoln Nissley (S R J–Oct.) 1500 w.

†25499. The Coming Convention at Atlanta. Ill. (S R J–Oct.) 6000 w.

25541. Compressed Air Tramway System in Paris. Ill. (S R G–Sept. 29.) 350 w.

25631. The Myrtle Avenue Improvement on the Brooklyn Elevated Railroad. O. F. Nichols (E N–Oct. 4.) 1800 w.

*25740. The Claret-Wuiblemier System of Electric Traction. Ill. (El–Sept. 28.) 1000 w.

25745. Street Regulations. Albert B. Weimer (S R G–Oct. 6.) 900 w.

†25781. The American Street Railway Association. Ill. (S R J–Oct.) 5000 w.

†25782. Atlanta, Her People and Her Industries (S R J-Oct.) 6000 w.

†25783. Principal Cities of the South and Their Street Railway Systems. Ill. (S R J-Oct.) 23500 w.

†25784. A Short History of the Street Railway Industry. Ill. (S R J–Oct.) 14000 w.

Serials.

21260. Electric Traction. C. H. Wilkinson (E P–Began April—Ended Sept.—5 parts—30 cts. each).

23795. The Lyons-Oullins Electrical Tramway. Ill. J. Berthon (E R L–Began July 13—3 parts to date—30 cts. each).

24308. The Florence and Fiesole Electric Railway (R P–Began Aug.—Ended Sept.—2 parts—30 cts. each).

24659. An Electric Railway System for London. Ill. J. H. Greathead (E Rev–Began Aug.—Ended Sept.—2 parts—30 cts. each).

24990. Joints for Girder and T-Rails and a Bond Adapted to each. Ill. James M. Price (S R G–Began Sept. 8—2 parts to date—15 cts. each).

25022. The Working Expenses of Electric and Cable Railways (R W–Began Sept.—1 part to date—30 cts).

25348. Mechanical Traction for Tramways (E E L–Began Sept. 14—2 parts to date—30 cts. each).

25599. Notes on the Management of Railway Power Stations. George T. Hanchett (E W–Began Oct. 6—1 part to date—15 cts).

SCIENTIFIC MISCELLANY

Evaporation from Water Surfaces.

Mr. L. G. Carpenter, Professor of Engineering in Colorado Agricultural College, has communicated to *Engineering News* an account of observations on evaporation from water-surfaces which have been carried on for six years at the college named, situated at Fort Collins, Colo. Under the title "Observations on Evaporation from Water Surfaces in Colorado," the journal quoted has printed Professor Carpenter's communication, which is of much practical importance to engineers, as illustrating methods of determining surface evaporation, and is also of general scientific interest.

Prof. Carpenter used a tank having a length, breadth and depth respectively of three feet, which he has made his standard. The upper surface exposed is, therefore, one square yard. This tank is placed in the ground. He also has used at intervals four or five small tanks for comparison, and has "had, for several years, tanks floated in lakes in a neighboring canal, and in a river, in such manner that they would have nearly the same temperature as the surface of the water in those places, and be exposed to the same conditions." Measurements in the standard tank were made by means of a hook gage which permitted readings less than thousandths of a foot. From April or May to September, two daily observations are made, and from and after Sept. 1, only one daily observation. Prof. Carpenter observes that after Sept. 1 the early sunset interferes with the second observation.

During the winter when the water is frozen, the observations are made but once or twice a month, which is done by completely separating the ice from the sides of the tank, and reading the surface height of the water as in the other observations. At the same time observations are also taken of the temperature of the water surface, temperature and humidity of the air, vapor tension, the movement of the wind, etc. During one season the temperature of the water 1 foot below the surface was also taken. Allowance is made for rainfall.

Prof. Carpenter states that the observations made have not been reduced for several years past, owing to stress of other work, and the editor of *Engineering News* justly remarks, after giving Prof. Carpenter's communication, that "the long period over which the observations have extended and the evident care with which they have been made render it very desirable that the results should be fully tabulated and published, both for local benefit and for the good of the engineering profession at large."

Besides what has been noticed in this important communication so far, it contains a great deal of useful information concerning the difficulties to be overcome and sources of error to be avoided in order to render the results of such observations trustworthy. Among essential points it is necessary that an accurate wind record should be kept. The determination of evaporation from surfaces according to Prof. Fuertes, is more difficult than the determination of rain fall; and this assertion is confirmed by Prof. Carpenter.

"It may be that this is largely true, because observers have too often expected to find the depth of the layer evaporated from a free water surface nearly the same throughout a given region and that the differences would be greater than are found with rain fall. It cannot be emphasized too much that evaporation is almost entirely a local phenomena. The amount depends almost entirely on the conditions of the special point. It depends not only on the moistness of the air, which may be fairly uniform over considerable areas, but particularly on the rapidity of the wind at the water surface or near by which serves to remove the saturated air, and the temperature of the water surface itself. These will vary according to the exposure, and the temperature will vary according to the amount of water, its surroundings, the depth and many other conditions, so that the difference of temperature in different bodies of water in the same locality is often considerable. It is the temperature of the surface itself rather than of the body of water, which determines the rate, because the phenomenon is a surface one. It does not require any great difference of temperature to make a marked difference in the rate of evaporation. Thus in the course of a single month, the evaporation from a neighboring reservoir was at twice the rate of evaporation from our tank placed in the ground. The difference was almost entirely due to the warmer temperature of the water in the reservoir, and though this was but 10°, it was sufficient to account for the double rate, as shown by application of our formula. It is because of the varying temperature of each separate exposure that the evaporation is so variant even in the same locality. Accordingly the observations taken under one set of conditions will give results which may be very misleading if applied to other conditions, unless the effect of each element which enters can be allowed for."

Prof. Carpenter deems it of high importance in making observations that "the temperatures of the surface of the water be taken." He regards the Piche evaporometer as an unreliable indication of surface evaporation, and gives his reasons for this view. He expresses his opinion that most reports of observations or evaporation made in various places are "not very valuable, because the conditions of the observations have not been sufficiently given." On the whole, he regards Fitzgerald's observations as the best yet made. Fitzgerald's formula, is, however, based on hourly observations, which Prof. Carpenter regards as "generally impracticable under the conditions to which engineers are subject"; and he closes his interesting communication with a brief reference to the observations reported by Mr. J. D. Schuyler, and included in the report of the state engineer of California for 1878–89.

Where the Teak Wood Grows.

AN article of both scientific and practical interest, gracefully written by Marion Manville Pope, superbly illustrated, and printed in *The Century* for October, is one of the best contributions of its class to the literature of the month. To quote the language of the introductory paragraph, it takes the reader "into the heart of untrodden jungles, on thick-wooded hillsides, leaning over the brinks of precipices, where tropical creepers twist like snakes, choking the life out of younger growths, where orchids flaunt aloft, and strange flowers bloom,"—where the teak-wood grows. It not only gives its readers this delightful free excursion, but the society of a most agreeable companion who knows what will be of interest to those who have not been over the ground, and guides them to it.

The teak-wood tree (*Tectona grandis* is its botanical name—often also called the "Indian Oak," both the tree and its timber being called oak as well as teak by the author of the article) supplies probably the most valuable timber for many industrial purposes that grows on the face of the globe. It is heavier than water, and is hard and extremely resistant, not only to atmospheric influences, but to the attacks of insects.

That atom of animate destruction, the white ant, has passed it by. Other growths have reared their heads out of the jungle around it, have grown, have lived their day, died, and rotted back to the roots which supplied them with life. In comparison man has been a midget, a mote in the sun, hunting his fellow-animals with flint-headed arrows and stone axes, flitting, passing, gone; but the great oaks have grown, have spread their arms benignantly over the dust of tiny shapes beneath, and, planted in dignity, have stood as emblems of strength and power in meditations lasting one, two, three, five, and six hundred years.

Yet, "out of these emblems of strength has grown a weakness that has overthrown a nation," says this pleasant writer; thereby implying that this valuable timber growth was a factor in bringing the Burmese under the British yoke.

The gathering of this timber store has been an industry ever since man of any color inhabited the country. Teak grows only in India and Burmah, and in old palaces and temples it has held indestructible place for many generations. From the color of sandal-wood it changes with age to walnut-brown. Big unpainted bungalows standing upon pillars of the wood, sided with it, shingled with it, latticed with it, defy heat and rain, and grow rich upon their poverty of oil and varnish. They stand, as brown as autumn, out of green compounds against summer itself. Vines wrap them, flowers garnish them, years add moss and lichen, but nothing destroys save flame. Railroad car-wheels, spikes for laying track, pegs for bolts, implements of all sorts, are made of teak. No one save a shipwright knows just how many parts of a ship are built from this muscle of nature, but every one who has walked the deck of bark or steamer has a consciousness that no amount of holystoning, or dragging of cargo over, or wear and tear of feet and traffic, can in an ordinary sense affect a teak-wood floor.

The Burmese wood-carver knows his art is almost hewn in stone when he coaxes leaf and flower, sacred cow and festival-cart, grotesque sprites and elves, gods and Buddhas, out of rugged trunks. The little prow of the sampan shaped like a wishbone, the stern of a paddy-boat as brown with age as the naked figure upon it is with the elements, the strange plinths of stranger pillars, the embellishments of the temples, the playthings of the children—all these are carved from teak.

The teak lumber business is, we are told, a strange industry; and when it is presented to us so graphically by pen and pencil, and we are invited to contrast it with what we know of lumber gathering in Northern and Western lands, we realize that the word "strange" is not misapplied. We think of the derricks by which huge beams and logs are lifted and swung around to desired positions in English, Norwegian and American timber yards, and here in the teak-yards to which we have been transported, we see living derricks doing the same work—trained elephants grasping heavy timbers with their trunks, and placing them as desired, each obeying the directions of a bare-waisted, bare-legged, dusky *mahout* (our guide here explains that the Burmese for *mahout* is *oozee*) stepping over and between other timbers strewn about the yard, and using tusks as well as trunks and their broad foreheads as the exigencies of their tasks demand.

To any one for whom machinery has a fascination there is nothing stranger than the first glimpse of elephants at work about it. Amidst the hissing swish of belting, the buzz of saws, the multitudinous separate rattles mingled into a universal roar and vibrating through a big saw-mill, the ponderous figures of these slow-paced helpers present a curious sight. One elephant places the log upon a movable platform to be squared, while another waits with restless eyes and flapping ears until the saw has done its work, and then, taking a twist in an attached rope, slips the loop of it deftly over a big tusk, and leads the log away. Another piles timber, lifting the long piece between tusks and trunk, and pushing it into place with the latter if the pile is low, or with a broad forehead if the height demands it. Fetching and carrying, lifting and stacking, pushing and pulling, these docile and patient giants do their work without complaint, week in and week out.

The reviewer reluctantly leaves this delightful article, hoping by the quotations made from it that he has been able measurably to indicate its character. Much interesting information is given in it, especially as regards the care which all civilized nations, except the United States, are bestowing upon the systematic conservation of their forest wealth.

The Vaccination of Land.

SOME editorial notes printed in the *American Architect* upon this curious process have been run together and printed as one continuous paper in the *Scientific American*. If all that is asserted regarding the process prove to be true it will result in incalculable benefit to agriculture and to the human race. The process is the logical outcome of some of the most remarkable agricultural experiments ever made which have been fully described in *Le Genie Civil* from which the *American Architect* derived the information contained in the editorial notes referred to. If the results of the experiments are in every respect as stated, it is impossible to exaggerate the importance of the discovery which has been made. It is impossible here to give a full résumé of these experiments, or the results alleged to have been attained. The statements are, however, made on high authority, and until disproved their credibility must be accepted. The discovery is in line with many others which have been made in recent times through researches in bacteriology.

For a long time it has been known to agriculturists that rotation of crops has had a renovating influence upon the soil; but up to a recent period the cause of this effect has eluded investigation. Chemical analysis has seemed to show that the land cultivated in this way gained nitrogen; and it has been supposed by many that certain plants possessed the power of absorbing nitrogen and imparting it to the soil in some form which enabled it to be retained for the nourishment of subsequent crops. Very thorough investigation by eminent scientists failed, however, to confirm this theory; and finally the consensus of scientific opinion became opposed to the belief that any plant, of whatever kind it might be, could act in this way. Nevertheless the experience of farmers in the rotation of crops still maintained the belief that some agency thus brought into play restores nitrogen to soil which has been impoverished by previous crops. Thus the matter stood until the problem was attacked by Hellriegel and Willfarth "who demonstrated beyond question that the leguminosæ in growing do absorb large quantities of nitrogen from the air, but with the singular condition that this absorption of nitrogen begins only with the appearance of a diseased state, which is marked by the development of tubercles about the size of a millet seed on the roots, and is, apparently, caused by minute animals which are always found in the tubercles, and seem to give the plant the nitrogen absorbing power.

Further investigations showed that the young, healthy plants lived on the nitrogen already contained in the soil, and that it was not until this was exhausted, and the plants began to suffer, that the nitrogen absorbing excrescences made their appearance; and, proved, also, that the tiny inhabitants of the tubercles were, as a rule, confined to one species of plant, the acacia microbe, for example, refusing to live on the bean, or the clover microbe on the lentil.

It is evident that a plant capable of absorbing nitrogen, which is a costly as well as indispensable adjunct to farming, and of storing it up n the soil for its master's profit, is a valuable possession; and, as only diseased plants have hat property, it is obvious that it is desirable to spread the nitrogen-storing disease. With this view, several skillful farmers in France and Germany have, within the past two or three years, been trying experiments, by "vaccinating," as they say, fields of leguminous plants, by sprinkling them with earth in which tuberculous plants have been growing, or water in which they have been soaked; and the results have been extraordinary. Analysis has shown that a single crop of tuberculous leguminosæ, if the tops are plowed in, adds to the soil from five to twelve thousand pounds of nitrogen, worth from eighteen to forty-five dollars, to the acre; and even when the tops are cut and carried away, there is enough nitrogen left in the roots to insure a good crop of cereals on the same ground the next season, without other fertilizer.

Following up this line of experiment, the results alleged to have been obtained with various crops is altogether so extraordinary as to almost stagger belief, but for these the reader must consult the article itself. It may yet prove that the land available for cultivation in the world will be sufficient to sustain a very much larger population than has hitherto been supposed possible by students of the subject.

The Granary of the Continent.

In an interesting illustrated but unsigned article written for *Milling*, a deserved tribute is paid to the influence upon the development of the great grain producing regions of the western United States which has been exerted by the writings of trained journalists, among whom are named Horace Greeley, Samuel Bowles, Albert D. Richardson, Henry Villard, Thomas W. Knox and William Phillips, a galaxy of honored names in the history of American journalism. But in dealing with other elements which have coacted to accelerate a progress unparalleled in the world's history, the writer puts himself in closer touch with the industrial interests to which this magazine is devoted.

First the pioneer element of hardy adventurers, exploring, discovering, and telling to the civilized world behind them the enormous resources that lay beyond. Then the railroads piercing the wilds soon to be brought into the sisterhood of States. And last, but not least, the advent of improved agricultural machinery. These are the forces whose combined effect has been to populate a region large enough for a dozen kingdoms; to make it the food producing region for a large part of the world; to cover its lakes and rivers with swift floating commerce; to dot its broad fields with white-spired prosperous villages, and to rear on its centers of trade large and populous cities whose growth has amazed the old world.

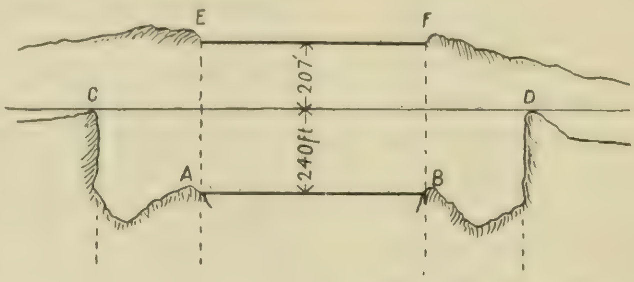
A comparison between the small farms of the east "where small farms are the rule," and the broad grain fields of the west, "where small farms are the exception," is made. The illustrations of powerful harvesting machinery, some of which require teams of from 25 to 30 horses to draw them, and other harvesting scenes presented in the illustrations reprinted from the *Northwest Magazine*, are pictures of what can be seen nowhere in the world except in the great "granary of the west." And when it is remembered that this giant progress would have been utterly impossible but for the resources which science has placed at the command of mechanical skill and genius, still only a very partial and meager conception of what science has done, is doing, and is destined to accomplish for the human race, will be gained. "Eye hath not seen nor ear heard," nor yet has the mind of man conceived what is in store for future generations, when hearts now living shall be stilled, and the eyes that now see dimly some little part of what is to be, shall have closed forever.

The Recent Eruption in the Crater of Kilauea.

An extremely interesting article under the above title is printed in *The American Journal of Science* for October. A description of the eruption is given by L. A. Thurston, and is copied from the *Pacific Commercial Advertiser* of July 23, 1894. He states that the great lava lake in the southern extreme of Kilauea Halemaumau has been steadily rising since the last great discharge in March, 1891, when an area 2500 feet long by 2000 feet wide sunk in one night a distance of over 500 feet. "The rising and overflowing of the lake filled this pit last fall; since that time the activity of the lake has been intense, as many as twenty-three overflows of liquid lava having taken place in a single day, and the walls surrounding the lake have been rapidly raised by continued overflows."

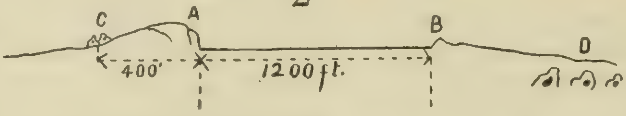
He states that accurate measurements of the lake were made by Mr. F. E. Dodge of the Survey Department in August, 1892 and March, 1894. Mr. Dodge has reported in the Volcano House book the result of these observations. The profile view of the lake at the two periods is shown in Figure 1. A B, level Aug. 1892; C D, rim of pit, 1891, E F, surface level March, 1894.

1



Upon arriving at the volcano on July 5, 1894, the principal change since Mr. Dodge was there was found to be the sudden rising of the north bank of the lake, covering an area of about 800 feet long by 400 wide, which, on the 21st of March last was suddenly and without warning elevated to a height of 80 feet above the other banks and the surface of the lava, the lake being then full. The raised area was much shattered, and two blowholes shortly afterward made their appearance on the outer line of fracture. On the 18th of April the hill thus formed began to sink, and on July 5th was only about 30 feet above the other walls of the lake. On the evening of the 6th of July a party of tourists found the lake in a state of moderate activity, the surface of the lava being about 12 feet below the banks. On Saturday, the 7th, the surface of the lake raised so that the entire surface was visible from the Volcano House. That night it overflowed into the main crater, and a blow-hole was thrown up some 200 yards outside and to the north of the lake, from which a flow issued. There were two other hot cones in the immediate vicinity which were thrown up about three weeks

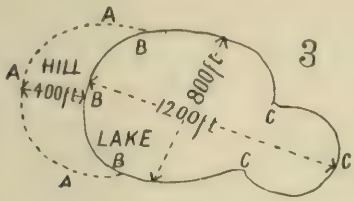
2



before. On Sunday, Monday and Tuesday, July 8th, 9th and 10th, the surface of the lake rose and fell several times, varying from full to the brim to 15 feet below the edge of the banks.

Figure 2 is a diagram exhibiting the condition of surface of the lake on Tuesday night, July 10th, of the same year. Figure 3 illustrates the outline of the lake and the position of the hill mentioned in the paragraph quoted as surveyed on the morning of the 11th July.

3

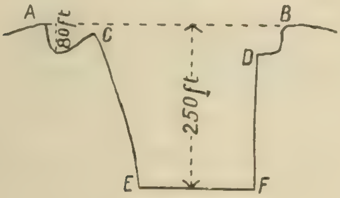


The lava in the lake continued to fall steadily, at the rate of about 20 feet an hour from 10 o'clock in the morning until 8 in the evening. At 11 A. M. the area formerly occupied by the hill, marked A, A, A, in the diagram, began to sink bodily, leaving a clean line of fracture ; the line of this area, marked B, B, B, was continuously leaning over and falling into the lake. From about 12 until 8 in the evening there was scarcely a moment when the crash of the falling banks was not going on. As the level of the lake sank, the falling rocks of the banks, undermined by the escape of the lava, caused a constantly increasing commotion in the lake as they struck the surface of the molten lava in their fall.

The following is also quoted from this interesting description of a convulsion whose grandeur is scarcely conceivable :

About noon the sinking lava disclosed the fact that the small extension at the right of the lake was only about 80 feet deep, and it was soon left high and dry, simply a great shelf in the bank, high up above the surface of the lake. As the lava subsided, most of the surrounding banks were seen to be slightly overhanging, and as the lateral support of the molten lava was withdrawn, great slices of the overhanging banks on all sides of the lake would suddenly split off and fall into the lake beneath. As these changes took place the exposed surface, sometimes 100 feet across and upward, would be left red hot, the break evidently having taken place on the line of a heat-crack which had extended down into the lake.

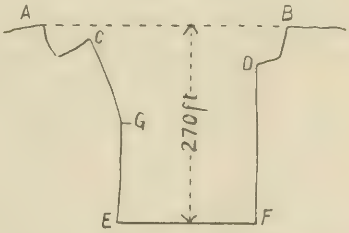
4



About 6 o'clock the falling bank adjacent to the hill worked back into a territory which, below 50 feet from the surface, was all hot and in a semi-molten condition. From 6 to 8 o'clock the entire face of this bluff, some 800 feet in length and over 200 feet in height, was a shifting mass of color, varying from the intense light of molten lava to all the varying shades of rose and red to black, as the different portions were successively exposed by a fall of rock and then cooled by exposure to the air. During this period the crash of the falling banks was incessant. Sometimes a great mass would fall forward like a wall ; at others it would simply collapse and slide down making red hot fiery landslides ; and again enormous bowlders, as big as a house, singly and in groups, would leap from their fastenings, and, all aglow, chase each other down and leap far out into the lake.

The awful grandeur and terrible magnificence of the scene at this stage are indescribable. As night came on, and yet hotter recesses were uncovered, the molten lava which remained in the many caverns leading off through the banks to other portions of the crater, began to run back and fall down into the lake beneath, making fiery cascades down the sides of the bluff. There were five such lava streams at one time.

5



The almost entire absence of sulphurous vapors is one of the peculiarities of this eruption noted. No difficulty in breathing was experienced directly to the leeward of the lake. At 8 o'clock in the evening the profile was approximately that shown in Figure 4, and Figure 5 exhibits it as it appeared at 9 o'clock in the morning of July 12.

A very meager impression of the interest of this article is conveyed by this review. It seems impossible to leave out any part of the paper without defeating the intention to represent it at its full value, both scientifical, and as a popular description of a grand and interesting event.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24945. Causes and Effects of Forest Fires. John Gifford (E Mag-Nov.) 3000 w.

*24946. The Land of the Mikado. J. Castell Hopkins (E Mag-Nov.) 3000 w.

*24951. Past and Present of the Whaling Industry. Ill. Herbert L. Aldrich (E Mag-Nov.) 3000 w.

24966. Rain-Making Down to Date. J. R. Sage (W A-Sept.) 1800 w.

24981. Plans to Improve Future Transportation. Editorial (A M & I W-Sept. 7.) 800 w.

†24998. Notes on the Pleistocene of the North-west Territories of Canada, North west and West of Hudson Bay. J. Burr Tyrrell (G M-Sept.) 2500 w.

†25000. The Most Recent Changes of Level and Their Teaching. The Rapid Collapse of Some Districts at the Close of the Mammoth Age. Henry H. Howorth (G M-Sept.) 4400 w.

25013. The Eddy Malay Tailless Kite. Ill. (Sc A-Sept. 15.) 1800 w.

25052. Sea Salts and Carbonates. J. A. Dewe (Sc A S-Sept. 15.) 5700 w.

25055. The Sinking of the Kow Shing (A & N J-Sept. 15.) 900 w.

25076. The Cryolite of Greenland. Francis H. Knauff (M & B-July.) 900 w.

†25084. Tire Protectors: Have They a Future? (I R W-Sept. 15.) 1200 w.

†25085. Some Features of the Pará Rubber Trade (I R W-Sept. 15.) 900 w.

†25086. Our Warning from the Naval Manœuvres. William Laird Clowes (N C-Sept.) 7000 w.

†25088. The Question of Korea. Henry Norman (C R-Sept.) 5600 w.

†25090. Possible Developments in Naval Armament. James Eastwick (C R-Sept.) 2800 w.

*25111. The Diffusion of Light by Dull Surfaces. Christian Wiener (El-Sept. 7.) 4000 w.

*25122. The Distribution of Compressed Air in Paris. Ill. (E-Sept. 17.) 1500 w.

*25127. A Direct Reading Form of Platinum Thermometer. G. M. Clark (E-Sept. 7.) 2000 w.

†25141. Leonardo da Vinci as a Pioneer in Science. William R. Thayer (Mo-July.) 13000 w.

†25144. Notes on Aërial Navigation. V. E. Johnson (W R-Sept.) 3300 w.

*25148. Kite and Kite Flying, as Applied to the Study of Meteorology, Wind Pressure and Aeronautics. V. E. Johnson (Inv-Sept. 8.) 2700 w.

*25149. Artificial Silk; or the Silk-Worm Superseded (Inv-Sept. 8.) 1200 w.

*25157. Japanese Inlay (I C B-Sept. 7.) 1400 w.

*25158. Mosaic Inlay and Buhl (I C B-Sept. 7.) 1200 w.

25160. The Salt in the Sea and Where It Goes. (Extract) J. A. Dewe (M Rec-Sept. 13.) 1400 w.

25161. Age of Niagara Falls (M Rec-Sept. 13.) 1500 w.

25180. Microbes Purify Water (F W-Sept. 15.) 1500 w.

†25200. The Professional Training of Teachers. M. V. O'Shea (P S M-Oct.) 5000 w.

25214. Rates of Precipitation in Rain Storms at Ithaca, N. Y. James H. Fuertes (E N-Sept. 20.) 800 w.

25219. A New German Military Balloon. Ill. (Sc A S-Sept. 22.) 300 w.

25222. The New Gas. (Sc A S-Sept. 22.) 600 w.

25226. Along the Coast of Kent. W. H. Booth (A M-Sept. 20.) 2400 w.

*25241. The Difference in Amount of Radiation Required in Buildings of Good and Poor Construction. E. P. Bates (D E-Sept.) 3500 w.

*25253. Japanese and Chinese Porcelains and Their Imitations. Saburo Arai (L Mag-Oct.) 1200 w.

*25271. Report on the Waltham Abbey Explosion. Editorial (Eng L-Sept. 14.) 1300 w.

25297. Fuel Economy. Editorial (A M & I W-Sept. 21.) 800 w.

25300. How to Extinguish an Oil Fire in a Cellar. C. F. Wall (F W-Sept. 22.) 1200 w.

25303. Patenting a Flying Machine. Letter of Hiram S. Maxim (B J C-Sept. 22.) 900 w.

*25318. Hermann von Helmholtz. Editorial (El-Sept. 14.) 1500 w.

*25323. Santa Fé as a Field for Emigration (B T J-Sept.) 1800 w.

*25326. Tariff Changes and Customs Regulations. Russia, Belgium, Spain, Portugal, China, Japan, Peru, West Africa, etc. (B T J-Sept.) 5500 w.

*25350. The Latest Views on the Problem of Mechanical Flight (Inv-Sept. 15.) 1500 w.

*25367. Hermann von Helmholtz (N-Sept. 13.) 1600 w.

25371. Origin of Gold. Editorial (M I T-Sept. 20.) 1500 w.

25385. Notes from the Antwerp Exhibition (Sc A-Sept. 29.) 1800 w.

25386. The Vaccination of Land (Sc A-Sept. 29.) 1000 w.

25387. Speaking Watches. Ill. (Sc A-Sept. 29.) 700 w.

*25399. The Significance of the Japan-China War. Michitaro Hisa (F-Oct.) 5000 w.

†25401. Astronomy and Religion. Edwin Arnold (N A R-Oct.) 4200 w.

25411. Decimal Time (E N-Sept. 27.) 1100 w.

25415. Observations on Evaporation from Water Surfaces in Colorado. L. G. Carpenter (E N–Sept. 27.) 1200 w.

*25453. Experiments in the Liquefaction of Hydrogen (C G–Sept. 21.) 1400 w.

*25471. Engineers of To-Day and Yesterday. Hamilton G. Castner. Ill. (E Rev–Sept. 20.) 1800 w.

*25477. The Tell-el-Amarna Tablets (A L–Sept. 21.) 3000 w.

*25488. Geologies and Deluges. Address of Prof. Sollas (N–Sept. 20.) 8500 w.

*25490. Science at the Beginning of the Nineteenth Century. Paul Carus (Ch–Oct.) 4200 w.

*25519. The Granary of the Continent. Ill. (Mill–Sept.) 1300 w.

†25532. Where the Teakwood Grows. Ill. Marion Manville Pope (C M–Oct.) 2000 w.

*25537. A Standard of Efficiency for Engineers (P Eng–Sept. 21.) 1800 w.

†25544. Methods and Apparatus for Drying with Heated Air. E. M. Cook (P E C P–April-June.) 6000 w.

†25548. An Auriferous Conglomerate of the Jurassic Age from the Sierra Nevada. W. Lindgren (A J S–Oct.) 2400 w.

†25549. On the Double Chlorides and Bromides of Caesium, Rubidium, Potassium and Ammonium with Ferric Iron, with a Description of Two Ferro-ferric Double Bromides. P. T. Walden (A J S–Oct.) 1500 w.

†25552. Notes on the Miocene and Pliocene of Gay Head, Martha's Vineyard, Mass., and on the "Land Phosphate" of the Ashley River District, South Carolina. William H. Dall (A J S–Oct.) 1700 w.

†25553. On the Thermo-Electric Properties of Platinoid and Manganine. B. O. Peirce (A J S–Oct.) 1400 w.

†25556. On the Age of Manganese Beds of the Batesville Region of Arkansas. Henry S. Williams (A J S–Oct.) 2500 w.

†25557. The Present Status of High Temperature Research. Carl Barus (A J S–Oct.) 1100 w.

†25558. The Recent Eruption of the Crater of Kilawea. L. A. Thurston (A J S–Oct.) 1700 w.

25571. How to Save the Palisades (G & F–Oct. 3.) 1100 w.

25625.—$1.50. A Few Remarks about the Niagara Gorge. Ill. L. L. Buck, with Discussion (T C E–Aug.) 3500 w.

†25642. Nanno, a New Cephalopodan Type. Ill. J. M. Clarke (A G–Oct.) 1100 w.

†25643. The Relation Between Base leveling and Organic Evolution. J. B. Woodworth (A G–Oct.) 9500 w.

†25644. Tertiary and Early Quaternary Base-leveling in Minnesota, Manitoba and Northwestward. Warren Upham (A G–Oct.) 4000 w.

25669. Apparatus for the Determination of Temperature in Glass Furnaces (A M & I W–Oct. 5.) 2000 w.

*25673. The West Point Soldiers' Monument. Ill. (E–Sept, 28.) 2300 w.

*25676. The Naval Battle. Editorial (E–Sept. 28.) 1800 w.

*25701. Electricity as a Fertilizer (L A–Sept.) 700 w.

25711. Are We Ruined by Science? The Deterioration of Man Under Its Influences (B J C–Oct. 6.) 2500 w.

25721. Ancient Monuments.—Choragic Monument of Lysicrates at Athens. Ill. (Ml N–Oct.) 500 w.

*25748. Aeronautic Engineering Materials. (Reprint from Cassier's Magazine.) R. H. Thurston (P Eng–Sept. 28.) 4000 w.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I–Began May—6 parts to date—45 cts. each).

23443. Sculptured Monuments of Boston. Ill. Frank T. Robinson (Ml N–Began July—4 parts to date—15 cts. each).

24240. On Some Life Zones in the Lower Palaeozoic Rocks of the British Areas, as Defined Mainly by Researches During the Past Thirty Years. Henry Hicks (G M–Began Aug.—2 parts to date—45 cts. each).

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng–Began Aug. 10—5 parts to date—30 cts. each).

24777. The Detection and Estimation of Small Quantities of Inflammable Gas or Vapor in the Air. Ill. Frank Clowes (J S A–Began Aug. 24—4 parts to date—30 cts. each).

24997. On a Collection of Jurassic Cephalopoda from Western Australia, with Descriptions of the Species. Ill. G. C. Crick (G M–Began Sept.—1 part to date—45 cts).

25168. Ancient and Modern History of Petroleum and the Mechanism to Determine Its Value as a Lubricant. Abraham W. Harris (M G–Began Sept. 15—Ended Sept. 22—2 parts—15 cts. each).

25280. Wood Pulp, and Its Conversion into Paper and Other Products (I & I–Began Sept. 7—4 parts to date—30 cts. each).

25313. The Manufacture of Briquette Fuel. William Colquhoun (I C T–Began Sept. 14—3 parts to date—30 cts. each).

25654. Aërial Navigation. A. F. Zahm (J F I–Began Oct.—1 part to date—45 cts).

25664. Letters to Young Engineers on Graphic Statics. Ill. E. G. I. McCudden (I E–Began Sept. 1—1 part to date—45 cts).

NEW BOOKS OF THE MONTH

A Text-book on Ore and Stone Mining. By C. Le Neve Foster, D. Sc., F. R. S., etc. Philadelphia: J. B. Lippincott Co. London: Charles Griffin & Co., Lt'd. [Cloth, large 8vo, xxviii-744 pp., 717 illustrations. $10.]

There are many general treatises on mining, having all gradations of merit, and of them this latest addition is one of the very best. The main difficulty in compiling a work of this kind is the wide extent of the field to be covered and the great diversity of the sub-topics into which the discussion ramifies. In the present case the author has met this difficulty as well as may be by occupying rather more than the usual space, thus being enabled to go from principles to examples in practice, and his selection of matter has been generally judicious, though it seems impossible for any writer on mining to avoid describing many things that are obsolete or obsolescent and on the other hand omitting many new features. The latter point applies especially to mining machinery, in which progress is continuous and so rapid that it would of course be hopeless to attempt to include everything new that is of value; and even if that were possible at any given date, a book so comprehensive would soon become a mere record, a sort of milestone on the track of progress, and would need to be supplemented from time to time by later and later additions. In essential principles the art of mining changes very little from one period to another, so that in this respect any one of the standard works (among which the present will take a high rank) is a fairly safe guide; whereas in details the treatises on special branches, the contributions to the various engineering societies and the technical periodicals must be constantly consulted by those who would keep pace with the times. Still, Mr. Le Neve Foster has managed to include a great deal of recent practice, and the reader will find in this book frequent references to events, discoveries and inventions down to as late as the year 1893, showing that in getting together his material the author has not lost sight of what is going on.

The standpoint of the author as to the true function of mining literature is wholly sound, and the idea thus expressed in the preface is kept in view throughout.

> Books and lectures are not intended to take the place of practical teaching [experience?] at mines; but they render the training more thorough and complete in many ways; they serve to explain the principles of the art, to solve difficulties which perplex the beginner, to suggest matters which he should observe, to tell him of those beyond his ken, and to supply him with a system for arranging his ideas methodically.

If all the makers and all the users of books on mining, and indeed on any technical subject, would regard the utility and limitations of such works in this light, there would be less disposition on the part of "practical" men to belittle book knowledge—a tendency which, however, is passing away.

The scope of this text-book is very wide—wider in fact than is often attempted. Besides the main subdivisions which one would naturally look for in such a book, there are chapters on the principles of employment of mine labor, on legislation affecting mines and quarries, on the condition of the miner (as to clothing, housing, education, etc.), and on accidents. Ventilation, which is usually touched upon lightly or relegated to books on coal mining, is given considerable prominence. The geological introduction (87 pages) contains a rapid survey of the common occurrence of minerals, and is followed by a chapter on indications in prospecting. The body of the book is arranged on the usual models of classification.

The author has endeavored to avoid restricting his work to the requirements of the British miner, and makes frequent citations of continental and Australian practice, with occasional mention of American systems; yet it was inevitable that a tinge of Cornish and Welsh methods—very sound, if not very progressive methods they are—should not have resulted from his environment and more special personal study.

This book, it will be noticed, includes "stone mining"; in fact almost everything except strictly colliery work. Besides the metals and metallic ores this means the occurrence and means of gaining a long list of mineral substances, such as building stone, slate, clays, flint, barytes, mica, diamonds, alum, amber, asbestos, graphite, gypsum, phosphates, sulphur, asphalt and ozokerite, various salts, petroleum, natural gas—and even ice. It will be easily understood that a large book could be written on either of these specialties, so that in a general work there is not much room for any single one of them. Then there is a long chapter on dressing, concentration and the preparation of minerals at the mine for sale or reduction.

The numerous footnote references to the literature of the subject are a useful feature. By following them up the reader who wishes to get fuller information and go more deeply into details will know where to look for what he wants. A. W., JR.

STANDARD WIRING FOR ELECTRIC LIGHT AND POWER. A Compilation of Formulæ, Rules and Requirements from the most Modern Practice, and in Accordance with the Rules and Requirements of the Boston Fire Underwriters' Union, the New England Insurance Exchange, and as Recommended by the Underwriters' International Electric Association. By H. C. Cushing, Jr., Electrical Inspector. Boston. Published by the Author. [12mo, roan, 62 p., illus. $1.]

IT is for many reasons eminently desirable that a work on electric wiring and construction should be written by an experienced insurance inspector. The inspector is a person who looks at the matter primarily from the standpoint of safety, and only secondarily from the standpoint of economy; but it is nevertheless true that in the long run the highest economy results from and is promoted by, absolute safety. Mr. Cushing has given, in compact and convenient form, an excellent résumé of the whole subject; including the proper installation of dynamos, motors and lamps, both arc and incandescent, outside construction and inside wiring, and a selection of approved tables and formulæ sufficient for the ordinary requirements of an installing engineer. These rules are in the main the same as those contained in the manuals issued by the General Electric Company for the instruction of its employés. Few questions are likely to arise in the mind of a wireman or engineer, as to just what construction will be regarded as safe by insurance people, which cannot be readily answered by reference to this handy little manual. The standard of outside construction called for may fairly be said to be in accordance with what at the present time passes for the best class of work in this country, but is nevertheless in many respects far below that which ought to be insisted upon to-day and which will in all probability be required ten years hence. The day will come when the unmechanical wooden cross-arm and wooden insulator pin, together with the uninsulating glass insulator will be relegated to the limbo of oblivion, and such futile devices for the "insulation" of 1000-volt currents from the exterior walls of a building as those illustrated at A and B on page 25 of Mr. Cushing's work will be extinct beyond possible resurrection. Insurance inspectors, and more particularly electrical engineers, should never for one moment forget that the first requisite of good construction is insulation; the second is insulation and the third is also insulation, and that the fundamental requisite of an insulator is that it shall insulate, not only in dry but in wet weather. FRANKLIN L. POPE.

BUILDING SUPERINTENDENCE. BY T. M. CLARK. 12TH Edition. Macmillan & Co. 1894.

THE book before us was originally published by James R. Osgood & Co. about fourteen or fifteen years ago, and as far as can be determined by a general comparison, the present edition is from the same stereotype plates as the first, without a word of revision or any effort to bring it up to date.

This is a very serious defect in any practical handbook, and is especially unfortunate in a book designed as a practical guide to beginners in architectural superintendence. The only way in which the superintendent of a building in course of construction can hope to make himself useful to his employer, the architect or the owner, is by being thoroughly well primed as to what work is contemplated by the drawings and specifications, and ready to give chapter and verse to the builder or the mechanic for an objection he may make or change he may order. Now Mr. Clark kept this well in mind, and wrote a very useful book, clear, concise and well arranged, and showing great discretion in following his subjects just far enough to put his readers on their guard, without confusing them, if beginners, with too many details and minor points. When this book was first written it was accepted by the profession generally as a standard work, and was very widely used.

Since that time, however, more new inventions have been adopted and more departures made in the materials and methods of construction than were seen in the three hundred years preceding, and the book as it stands to-day before us would be really dangerous in the hands of a beginner, owing to what it omits to mention.

It would be impossible to point out all its omissions without taking too much space, but in running over the book the following points " sautent aux yeux." The references to other text-books omit all the more recent works, such as Berg's and Hill's on modern fireproof construction, Waring or Gerhart on modern plumbing and sanitation, and no reference is made to electricity either for light or power. None of this had been done when Mr. Clark first wrote, but it is an old story to-day.

Redwood and cypress are not mentioned, nor are tile linings for chimneys, tile copings for walls, creosote or other stains for shingles, metal lathing, the various patent plasters, open fixture plumbing and the endless variety of all porcelain fixtures, steam and hot water heating, plaster-relief work, spring door checks, transom lifts, elevators, hard oil finish, electric lighting, and wiring for it, iron skeleton construction, foundation work for tall buildings, artificial stone for side-walks, etc., many forms of structural iron, telephones, typewriters, blue prints, mail chutes and many other things now in general use, were either unknown or rarely used when Mr. Clark first wrote, but it seems hardly fair to him or to those who may purchase the book before us, to date it 1894 and describe it in the sub-title as a " Manual for young architects, students and others interested in building operations *as carried on at the present day.*" The italics are ours.

ENGINEERING CONSTRUCTION IN IRON, STEEL AND TIMBER. By William Henry Warren, M. I. C. E., A. S. C. E., professor of civil and mechanical engineering, University of Sydney, N. S. W. London and New York: Longmans, Green & Co. [Cloth, large 8vo, xi-379 p., with numerous diagrams and folding plates. $5.]

THIS latest treatise on engineering construction is in entire harmony with the tendency evinced in the best recent text-books on all branches of engineering, to amplify and illustrate the discussion of underlying principles by introducing many practical applications by way of example—a system which relieves the monotony of the theoretical and mathematical discussion, quickens the reasoning faculty and makes plain what the mere enunciation of principles and formulæ fails sometimes to do. In another direction, the frequent introduction of graphic statics, the later text-books mark a great advance upon the older, and are clearer as to computations and design. The present work is intended not only for the use of students in civil engineering, but also for those engaged in the design of constructional iron and steel work.

The plan of the work includes the following leading topics: the strength and other characteristics of the materials discussed, with the methods and results of tests; determination of stresses; bending moments and shearing stresses; resistance moments, and intensity of various stresses; examples of small bridges and viaducts in metal and timber; graphic statics applied to the determination of stresses in structures; braced girders with parallel flanges; bowstring and polygonal girders; deflection of beams; continuous girders; columns; plates and bars, joints and connections; bridge decks; weight of main trusses and girders; plate web-girder deck bridges and through bridges; American truss bridges; wind pressure; braced piers; road bridges; swing bridges; arched and suspension bridges, etc. This partial list of topics indicates the wide scope of the treatise. The author proposes to supplement this book with a companion work on construction in brickwork, masonry and concrete, which will then round out the present treatise by adding the subject of foundations, so intimately associated with bridge construction.

In connection with the discussion of the fatigue of metal under repeated stresses, about which a good deal has been printed in this Magazine, it is interesting to note that Professor Warren followed the lead of Wöhler, Bauschinger and other experimenters, and from the recorded tests deduces an approximate ratio of vibrating strength to primitive strength to statical strength of 1: 2: 3. By "primitive strength" is meant the ultimate breaking point of a piece subjected to a load which is entirely removed before being reapplied.

A TEXT-BOOK ON ROADS AND PAVEMENTS. BY FRED P. Spalding, Assistant Professor of Civil Engineering in Cornell University. M. Am. Soc. C. E. First edition; first thousand. New York: John Wiley & Sons. [Cloth, 12mo, viii-213 p. Illustrated. $2.]

ANIMAL traction, by common consent, is doomed, even for country roads, in thickly settled regions; but the exact period at which it is to be done away with seems to be based on a sliding scale that reaches far into futurity. So far as can be foreseen in the light of recent progress the ultimate development of systems of transportation will be in the direction of economical feeder lines, either operated by steam or by electric-power transmission, or by both, culminating in a network which will make every farm and every country residence a railway station or terminus. But that millennial epoch is by no means yet in sight. For the immediate present there is an urgent demand for improved roads, and it is being earnestly pushed by the bicycle-manufacturing companies, the horse-breeders, the press, and lately has been caricatured by the Coxey crusade.

For the paving of city streets it may at last be said that we have reached fairly definite conclusions, depending upon the traffic conditions and only vitiated by the uncertain factor of funds available. Professor Spalding brings out very clearly the principles which should guide in the choice of road and street material and construction. As to country roads the comparison he draws between the macadam and telford systems is especially instructive; while in the line of street paving the author scrupulously distinguishes between the ideal and the practicable. If an adverse criticism may be ventured in regard to a work so excellent otherwise, it would be to remark that Professor Spalding perhaps carries his conservatism to such a degree in the praiseworthy attempt to fairly state all sides of a question, whenever there is more than one side, that he occasionally leaves the reader in some uncertainty as to the author's own preference.

The book is arranged in numbered sections. Some idea of its scope may be had from the following outline of topics, each of which forms the subject-matter of a separate chapter: general considerations; drainage of streets and roads; location of country roads; improvement of country roads; broken-stone roads; foundations for pavements; brick, asphalt, wood and stone-block pavements; laying out city streets.

In regard to the improvement of our common roads Professor Spalding strikes the keynote of progress by declaring that such improvement "must come through transferring the work to the charge of those who make it a profession, and not through teaching the public how roads should be constructed." Public interest is pretty thoroughly aroused as to the importance of the subject. It remains now to remove the road-building supervision and maintenance from the hands of county commissioners and boards, chosen for political motives and purposes, to the engineering profession, where they properly belong And it may be remarked here that for young students of civil engineering who are searching for a likely specialty there are few openings more promising just now than that of roads and paving, which line has only recently begun to be taken up as a regular profession, after having been neglected for about two thousand years, or since the period of the eminently practical Roman engineers.

BOOKS RECEIVED.

Bower, John A.=Simple Experiments for Science Teaching, Illustrating Elementary Physics and Chemistry. New York: E. & J. B. Young & Co. [Cloth. 12mo. 164 p. $1.]

Bowne, Thomas H.=A Few Hours' Talk with a Railroad-man. New York: Bowne Publishing Co. [Cloth. 12mo. 135 p. $1.]

Carwardine, *Rev.* William H.=The Pullman Strike [stating the side of the employés]. Chicago: C. H. Kerr. [Paper. 12mo. 135 p. 50 cents.]

Clauder, H. T.=What Time is It? A Manual of Instruction in Teaching and Reckoning Time, Longitude, etc. New York: W. Beverley Harison. [Paper. 12mo. 39 p. 30 cents.]

Drage, Geoffrey.=The Unemployed. New York: Macmillan & Co. [Cloth. 12mo. 277 p. $1.50.]

Earl, Alfred.=Practical Lessons in Physical Measurement. (Manuals for Students series.) New York: Macmillan & Co. [Flex. cloth. 12mo. 350 p. $1.25 *net*.]

Gifford, John B.=Elementary Lessons in Physics. Illustrated. Boston: Thompson, Brown & Co. [Cloth. 12mo. 8-161 p. 60 cents.]

Harper, Charles G.=Practical Handbook of Drawing for Modern Methods of Reproduction. Illustrated. Philadelphia: J. B. Lippincott Co. [Cloth. 8vo. 12-161 p. $2.50.]

Hobson, John A.=The Evolution of Modern Capitalism: a study of machine production. (Contemporary Science series.) New York: [imported by] Charles Scribner's Sons. [Cloth. 12mo. 15-388 p. $1.25.]

Hornby, John.=The Gas-Engineer's Laboratory Handbook. Illustrated. New York: Spon & Chamberlain. [Cloth. 12mo. 16-304 p. $2.50.]

Houston, Edwin James.=Electricity One Hundred Years Ago and To-day Illustrated. New York: W. J. Johnston Co. [Cloth. 12mo. 199 p. $1.]

Huxley, Thomas H.=Discourses Biological and Geological; Essays. ("Collected Essays," Vol. VIII.) New York: D. Appleton & Co. [Cloth. 12mo. 12-388 p. $1.25.]

Jacob, Ernest H.=Notes on the Ventilation and Warming of Houses, Churches, Schools, and Other Buildings. Illustrated. New York: E. & J. B. Young & Co. [Cloth. 16mo. 123 p. 30 cents.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

E. W. Bliss Co., Brooklyn, N. Y., U. S. A. =Catalogue of Flexible Friction Clutch Pulleys. [Describes and illustrates very fully the construction of these pulleys, with sizes and other general information.]

Harrisburg Foundry and Machine Works, Harrisburg, Pa., U. S. A.=The Harrisburg Double Engine Steam Road Roller, Patented. 19 large quarto pages. [Illustrations of various sizes of these machines and description of their details, including special rollers.]

Harrison Brothers & Co., Philadelphia, New York, Cincinnati, U. S. A.=Catalogue and Price List White Lead, Colors, Chemicals, etc. 92 p. [Handsomely illustrated, with much interesting matter relative to the mixture and use of paints, and a brief history of the house of Harrison Brothers & Co.]

Harrisburg Foundry and Machine Works, Harrisburg, Pa., U. S. A.=Portfolio of elegant illustrations of Automatic Engines and leaflet of the same.

Fairbanks, Morse & Co., Kansas City, Mo., U. S. A.=Pumping Machinery for Irrigation, ptepared from address by Ira C. Hubbell, of Kansas City, Mo., before Interstate Irrigation Association, Omaha Convention, March 21 and 22, 1894, etc. [A leaflet of 24 p.]

F. E. Reed Co., Brewster, Mass., U. S. A.= Special Wood Turning Lathe. 12 p. [Designed expressly for use in Manual Training schools.]

The Phosphor Bronze Smelting Co., Limited, Philadelphia, Pa., U. S. A.=Price List. 20 p., exclusive of cover.

Northwestern Expanded Metal Co., Chicago, Ill., U. S. A.=An Argument for Improved House Construction. 16 p., exclusive of cover. [Directions for applying and plastering expanded metal steel lath.]

Johnson Electric Service Co., Boston, Milwaukee, Minneapolis, Detroit, Pittsburg, U. S. A.=The Johnson System of Temperature Regulation. 40 p. [Illustrations of instruments and appliances with descriptive text and list of public buildings in which these appliances are used.]

Street Railway Publishing Co., New York, U. S. A.=Practical Notes on Rope Driving, by M. E. 48 p. [Reprinted from the Street Railway Journal.]

Harrison Brothers & Co., Philadelphia, Pa., U. S. A.=The Chemistry of Paints, and a partial Description of the Harrison White Lead Color and Chemical Works, with a Practical Treatise on Painting. 43 p. [Illustrated with tinted plates and portrait of John Harrison, founder of the house of Harrison Brothers & Co.]

Detroit Dry Dock Co., Detroit, Mich., U. S. A.=Howden Hot Draft System. 16 p. leaflet. [Describing and illustrating the system.]

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"THE BALTIMORE PLAN" OF CURRENCY REFORM.

By C. C. Homer and A. P. Hepburn.

IT requires no prophet to foresee that the question which must dominate all others in public interest during the coming twelve months, is that of reforming the polyglot system of currency and banking under which the commerce and industry of the United States are now struggling. Happily the tariff agitation has received its quietus for several years to come. If the Democratic tidal wave of 1892 was a protest against "Protection gone mad," it is idle to contend that the stupendous Republican victory of 1894 was not a protest against any further tariff tinkering by the party of radical revenue reform. Happily, too, the late elections have put an effectual quietus upon the pretensions of Populism. The blatant ignorance and absurd incompetency of the men it tossed into power have given ocular demonstration of the folly and fallacy of every theory that the party stood for. So, too, the earnest and aggressive advocates of free silver coinage have finally caused a popular upheaval which no one can misunderstand. The overwhelming defeat of the leader of the movement, Mr. Bland, a Democrat in one of the strongest Democratic districts of Missouri; the phenomenal victory of the sound-money Democrats in Republican California; and a popular majority of unparalleled proportions against the free-silver Democrats in Ohio,—these are definite expressions of aroused public opinion which show clearly that free silver coinage is a hopeless issue in the United States.

But back of the Populist demand for "more money" and "cheap money"; back of the sentiment favorable to silver coinage upon some safe basis; and back of the unrest and discontent which are

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manifest in all parties, there is the definite knowledge that our present currency system is both complicated and defective—that at certain seasons it is inadequate to commercial requirements, and in times of panic positively dangerous to the welfare of our people. This is the vital defect which gives plausibility to all the financial vagaries now prevalent; and whatever sins may be charged against the silver inflationists and the fiat money cranks, they must be credited with having finally aroused the conservatism of the country to a clear appreciation of the fact that financial reform is an imperative need.

It may be said that the movement for reform was inaugurated with the panic of 1893. The wholesale issue of clearing-house certificates, the widespread use of certified checks in place of money, and the premium, not on gold alone, but on currency as well,—these were object lessons in finance which brought home to every man the obvious truth that our currency system was defective, and that it lacked the essential quality of being readily expanded or contracted to meet perfectly legitimate requirements. Since that time the discussion has proceeded continuously in the daily press, and notably at all gatherings of commercial and banking organizations; and now comes the authoritative announcement from President Cleveland that the Secretary of the Treasury, Mr. Carlisle, will present at the coming session of Congress a plan of currency reform which will carry with it the recommendation and cordial support of the entire administration. This means simply that the currency question will henceforth take precedence over all others in public importance.

The pressing need for such action by our Treasury officials, and the heterogeneous character of our present currency system, can be best indicated by an exhibit of its component parts, as reported Oct. 1, 1894:

	Coined or Issued.	In treasury.	In circulation.
Gold coin	$579,728,587	$79,602,339	$500,126,248
Gold certificates	64,845,699	55,260	64,790,439
Silver dollars	421,176,408	366,900,165	54,276,243
Subsidiary silver	75,054,481	16,809,713	58,244,768
Silver certificates	339,676,504	9,155,785	330,520,719
Treasury notes (1890)	151,609,267	30,113,893	121,495,374
United States notes (greenbacks)	346,681,016	79,397,535	267,283,481
Currency certificates	56,305,000	550,000	55,755,000
National bank notes	207,564,458	5,017,748	202,546,710
Total	$2,242,641,420	$587,602,438	$1,655,038,982

In the language of Prof. J. Laurence Loughlin of Chicago, "We have here a dime museum of finance—'the greatest aggregation of curiosities ever before exhibited under one canvas in the world.' There are nine different and confusing kinds of money—two kinds of gold money, four kinds of silver money, and three kinds of paper money. The sum total of the four kinds of silver money amounts to about the same as the sum of the two kinds of gold money. Briefly, about 35 per cent. is gold, 35 per cent. is silver, and 30 per cent. is paper. . . . If anything should make us pause and deliberate on the ways of regulating our monetary system, it would be that the loud-voiced, blatant demagogue is allowed to have unimpeded influence in regulating such an intricate mechanism as this. Is it not about time that unpartisan commissions should be consulted?"

We have, of course, no information as to the terms of the plan which Mr. Carlisle will propose; but recent events of the highest significance in this regard afford us a very clear indication as to what the situation demands and what the intelligence of the country will approve.—THE EDITOR.

At the last annual convention of the American Association of Bankers on October 11, 1894, the Clearing-house Association of Baltimore, as a body representing the banking interests of that city, presented to the convention an outline of proposed amendments to the national banking act, which has come to be known as the "Baltimore plan," and has called forth the strongest approval from influential persons in all sections of the country. In brief outline, the plan proposes that bond security for national bank notes shall be abolished; that the banks shall be permitted to issue circulating notes up to 50 per cent. of their paid-up capital (and under emergency provisions an additional 25 per cent. may be issued); that the notes of failed banks are to be paid out of a "Guarantee Fund" created by an annual tax on all national bank notes sufficient to cover such failures; that the government shall have a prior lien upon the assets of each failed bank and upon the liability of shareholders, for the purpose of restoring the amount withdrawn from the "Guarantee Fund" for the redemption of its circulation; and otherwise that the redemption of all national bank notes and the close scrutiny and supervision of all national banking affairs shall be carried on by the government as at present.

Mr. Charles C. Homer presented the plan on behalf of the bankers of Baltimore, and in the course of his address he said in part:

> The solution of the currency problem is justly entitled to the greatest prominence, for modern history demonstrates that upon the character and stability of its finances depend the solidity and prosperity of a people. Commerce is the bond of union which ties together the nations of the earth, and welds the links that keeps destructive war chained captive to the chariot of peace. Money is the handmaid of commerce, and wheresoever the latter wanders in her search for healthful development, there her servant must be present, ready and able to respond to her commands. How important then the rôle of the dollar! It must be above suspicion; its character must be unquestioned; its value unchanging; its credit impregnable. How far much of our currency has been lacking in these necessary qualifications the finger of history has noted in indelible marks upon the pages of 1893.

From the birth of the first greenback, the patriotic student of finance has watched with solicitous eye the questionable assumption of constitutional power by our government; and while love of country and mindfulness of its dire needs softened the tones of warning involuntarily uttered, the cry of anguish could not be restrained when constant violations of our supreme law hurried us on to the calamities of 1893. Too much praise cannot be bestowed upon the far-seeing wisdom, the incisive judgment of our forefathers who framed the constitution of our country. "To coin money, regulate the value thereof, and of foreign coins," is the extent of the authority granted by this inspired instrument. Had its behests been regarded, the ruin, distress, and mental anguish we have just passed through would not have befallen our land.

We claim no novelty or originality for the plan which our Clearing-house Association has delegated me to present to you, and which it hopes may meet with the approval and advocacy of yourselves and of our entire country. Having lived and prospered for thirty years under the influence and blessing of the national banking system, which supplies every requirement except that of elasticity, we have aimed to outline an amendment which would not dwarf its good features, but which would be so broad and so liberal as to invite all state banks to come within its folds.

Our currency must be supplied by the banks,—*not by the government.* The banks are the arteries of commerce, feeling instantly the changes of commercial activity. It requires no demonstration or argument to prove that a flexible currency, responsive to the demands of commerce, can never be obtained so long as the institution issuing the same is required in advance to invest as much money or more in securities. To be elastic, it *must be based upon credit;* and the institution issuing the same must have for its sponsor the necessary government regulation, supervision, and examinations. The first Bank of the United States, which was allowed to issue circulating notes equal to the full amount of its capital, had in 1809 upon $10,000,000 capital $4,500,000 circulation, or 45 per cent.; in 1811, upon the same capital, $5,037,000, or 50 1-3 per cent. The second Bank of the United States, in 1835, with a capital of $35,000,000 had outstanding circulation amounting to $17,339,000, or 49½ per cent.

In the writings of Albert Gallatin, vol. iii, page 312, we find, speaking for the year 1830, the following interesting fact: "Among more than 300 banks, . . . the statements we have given show, that the average amount of notes issued by the state banks does not, taken together, exceed 44 per cent. of their capital." It is instructive to note that in 1859 Massachusetts had $61,819,000 bank capital with $20,839,000 circulation, or 29 3-5 per cent. and Louisiana $24,215,000 capital with $9,094,000 circulation, or 26 3-10 per cent. The laws of Massachusetts permitted circulation to double the amount of the capital, while no limit whatever was placed upon circulation in Louisiana.

To provide, however, for very extraordinary currency demands, such as confronted us all in 1893, we propose to permit the use of an additional 25 per cent., to be known as emergency circulation, subject to a severe tax. Its mission would be similar, but of broader utility, to that of clearing-house loan certificates, which performed such effective service last year, and by whose use immeasurable losses and ruin were averted.

The guarantee fund principle is not a new one. New York adopted it in 1829, but by an error or accident in framing the law, it was made to cover the deposits, as well as the circulation. Each bank was required to pay to the state treasurer one-half of one per cent. per annum upon its capital stock, until 3 per cent. had accumulated. In 1848, Millard Fillmore, then comptroller of the state, showed by his report, that the contributions to this fund had been $1,876,063, and the notes of failed banks amounted to only $1,548,558, leaving a surplus as against loss by circulation of $327,505.

Our currency must be national, its credit equally good North, South, East and West.

Commerce knows no state lines, and her hand-maid, the dollar, dare not halt upon the boundary of any state, timid as to her rights, hesitating as to her reception. In closing I can find no better words, in urging upon you the retention and adoption of the national bank system with the proposed amendments, than the following language of Mr. Horace White, whom we all esteem so highly :

"The public have more confidence in the machinery of governmental oversight and enforcement of law, under the national system, than they have under state systems ; and this they will continue to have, though some state systems are as good or better. They know that the national system is uniform. It operates in the same way in Washington city and Washington state, and everywhere between. When you know this law, and the decisions under it, you know all that is necessary. If you undertake to learn and keep track of the banking laws of forty-four states and four territories, you will find your task a heavy one. There is now a movement on foot to secure uniformity of law in the states touching the marriage relations, wills, conveyances of land, and some other things. As we actually have uniformity of law on the subject of banking, we had best keep it."

Among the speakers who followed Mr. Homer in advocacy of the plan, was Hon. A. P. Hepburn, ex-comptroller of the currency under President Harrison. The following extracts from his address give in concise form a most admirable exposition of the requirements of the present situation and the merits of the system proposed :

Sound-money advocates, relying upon the impregnability of their position, until roused from their lethargy by the dangers that culminated in the panic of 1893, were for a period of years quiescent. On the other hand, the champions of silver, with mines to work and a commodity to market, and the representatives of debtor communities, have sounded and resounded the demands of increasing trade and growing population for more money. They struck a responsive chord in the honest conviction of many. They say, "Opposed to free coinage ? What are you going to do ? Population and business are increasing ; our currency should increase in the same ratio. The government should not issue more fiat money. State-bank circulation is fraught with danger. National banks cannot supply currency, because government bonds as security are fast being retired. We must resort to silver as the only alternative."

The action of the bankers of Baltimore, so ably presented to the convention, and for which they deserve the thanks of the nation, is a complete answer to all this, and, Mr. Chairman, it is a timely answer. With the Republicans of California and the Democrats of Ohio demanding free coinage of silver at the ratio of sixteen to one, and varying shades of the same sentiment finding public and party expression in different localities, it is imperative that this convention of bankers formulate the principles upon which they believe the currency of the country should be founded.

Of all the time-worn fallacies there is none more venerable or vulnerable than the omnipresent attempt to create wealth or pay debts by legislation. The free coinage of silver at the ratio of sixteen silver dollars to one gold dollar of present weight and fineness, means a dollar commercially worth less than fifty cents, but by the fiat of the government made to pass for one hundred cents. It means that an individual may take $100 worth of silver bullion to the mint, and, coinage free, obtain silver dollars with which to pay $200 worth of debt, and would thus mean the repudiation of 50 per cent. of existing indebtedness. The sagacious instinct of trade would correct such wrong as to future contracts, by doubling the price of commodities. It means an inflation of prices without an increase of values. It means that the $600,000,000 of gold now in circulation would go to a premium, would cease to be money, would become a commodity simply, whether coined or uncoined. *It means a contraction of our currency equal to the amount of gold which ceased to circulate as money.* It means a general unsettling of values, the demoralization of business, a great injustice to present creditors.

Both the Bland law and the Sherman law injected into circulation a fixed amount of money monthly, without regard to wants of commerce. However great the demands of trade, they could not increase such amount one jot or tittle. A currency to be elastic must be issued against credit. Banks must have power thus to create money. In no other way can currency be elastic. In no other way can it meet the wants of commerce. From the very nature of things the government cannot give such a currency. The banks can, and the banks only can with prudence and safety be allowed to do so. There is no more money in the country in 1894 than there was in 1893. Now money clogs the vaults of our banks and begs investment at a lower rate per annum than the premium offered one year ago for a single service, and which failed to lure it from hiding in safes and vaults. Any volume of currency may prove inadequate in a panic. Still, had the Canadian law obtained in this country in 1893, the national banks could, under its provisions, have added over $500,000,000 to the currency of the country, and with such a law a currency famine would hardly have been possible.

An elastic currency is needed, not alone in times of distrust, but in course of ordinary business. The harvesting of the cotton crop calls for an extraordinary amount of money in the cotton belt. Currency is brought from the money centers to supply this need. Currency in that section is expanding. Under the system proposed the banks in the cotton region could largely supply this local demand, and to such extent save the expense of expressing money from money centers. The cotton crop having been moved, the demand for money lessens, and by the inexorable law of supply and demand, the currency contracts, flows back to money centers.

The proposed law follows closely the Canadian law, which embodies many good features from the national bank act and from the British and Scottish currency laws. It provides for the issuing of currency up to the par of unimpaired capital. The Baltimore plan allows only 50 per cent., and in an emergency, 75 per cent. The Canadian currency is redeemed out of a 5 per cent. guarantee fund, contributed and maintained by the banks. The government assumes no responsibility beyond the application of this guarantee fund. There has been no loss to bill holders, and the law has given satisfaction. Canada has been peculiarly free from panics for many years, and has had no currency famine. Thus the principles of the bills before us are approved by actual experience.

Under our present law the government is bound to redeem all notes of all failed banks, and is given a prior lien upon the assets of the failed banks to reimburse such payment. With this proposed law in force and without bonds to secure circulation, the government would, during the past thirty-one years, have lost not exceeding $1,139,253. An annual tax of three hundredths of 1 per cent. upon circulation would have covered this loss. Surely a 5 per cent. guarantee fund will make the notes proposed in this plan perfectly secure.

The experience of thirty-one years of our nation's history, years replete with many periods of depression, yet withal characterized by marvelous growth in population and unprecedented commercial and financial development—certainly constitutes a safe criterion upon which to base legislation for the future. The experience of other nations as well as our own demonstrates the safety, the wisdom, the necessity of a currency based upon the principles embodied in the proposed plan.

The business of banking consists in swapping a well-known credit for a less-known credit. If the well-known credit be a check or draft, it is used for special purpose and within business circles. If the well-known credit be in the form and semblance of money, a United States citizen is entitled to have it good as money throughout the United States.

History and experience point the wisdom of a national currency under national control; neither reason nor experience nor convenience nor public good would justify the creation of local currency. Under the proposed law, allowing circulation equal to 50 per cent. of capital, the banks could, and undoubtedly would, take out $350,000,000 of circulation, an increase of $150,000,000 over the present amount. The incorporated state banks have $250,000,000 capital, and should they, by conversion to the national system or otherwise, take our circulation, it would add $125,000,000 more—certainly sufficient for immediate wants, and being elastic, there is no danger of plethora, as it would flow back to the bank of issue whenever redundant.

Should Congress provide at any time for the retirement of the greenbacks or treasury notes, contraction may be prevented by increasing the percentage of bank-note circulation. All experience and all statistics prove a currency issue equal to par of unimpaired capital is absolutely safe.

By means of extensive correspondence with every considerable place in the country, I obtained statistics which justify the estimate that during the currency famine of 1893 there was issued clearing-house certificates to be used in settling balances, certified checks, certificates of deposit, and cashiers' checks in round amounts intended to pass as money, due bills from manufacturers and other employers of labor, and also clearing-house certificates in round amounts (in instances as small as 25 cents), all designed to perform the function of money, to the amount of $100,000,000. *They were issued against credit, and circulated as money upon the credit of the party issuing the same.* In other words, the want of elasticity in our currency system was thus partially supplied. *The government was powerless to afford relief. Its currency was as unresponsive to the wants of trade as the pyramid of Cheops.* Some banks borrowed United States bonds from savings banks and other institutions and took out circulation, but no bank could buy bonds and take out circulation without aggravating instead of reliving the money stringency.

We want legislation that will enable the banks to do, under proper restrictions and wholesome safeguards, what private firms and manufacturing corporations did do without restriction, except the possible liability to the 10 per cent. tax. The issuing of currency is a banking prerogative, and the interests of the public demand legislation that will enable the banks to afford such relief when necessary.

After such a presentation as is here indicated, it is scarcely necessary to say that the American Association of Bankers—the most imposing commercial body in the nation—gave the plan its formal endorsement. Since that time the banking and financial interests of every section of the country have given unmistakable evidence of approval; and judging by the outspoken commendation which it has received at the hands of our most influential economists, there can be no doubt that substantially the plan here outlined will at an early date be enacted into law. This too without regard to partisanship, for the business interests of the country will demand that Republicans and Democrats unite to enact a measure of such evident public utility.

SOCIAL IMPROVEMENT OF EUROPEAN LABOR.

By E. R. L. Gould, Ph. D.

VISITORS to continental Europe cannot fail to observe the large practical interest often manifested by employers in the social welfare of their help. Institutions have been founded and aids established which surpass anything in existence in Great Britain or the United States. My remark is to be interpreted generally. In two things, the provision of healthful homes for operatives and the foundation of workingmen's clubs, Anglo-Saxon countries make a more favorable showing.

Superficial observers have attributed this continental policy to an all-pervading spirit of paternalism or to an effort to hold the workingman in subjection, but they are in error. Wherever the institutions are most largely in operation, there is a keen appreciation of advantage on both sides, which makes both parties content to contribute. The initiative as well as the major expenditure belongs to the employer.

First of all it is important to apprehend clearly the principle underlying this general phase of social work. Broadly speaking, three leading ideas have been typified : the military, the patriarchal, and the spirit of philanthropic regard. The first two are often assumed to be most inclusive, whereas the third class is really the type.

Militarism in this field makes the worker a subject. His freedom is so entrammeled that individual or associated opposition to unjust treatment cannot well occur. Benefits doled at the good pleasure of the industrial captain either injure the recipient's self-respect and degrade his manhood, or arouse chafings and resentments.

Authority likewise supplants the idea of mutual help in a patriarchal régime. Under this system employés are minors with the day of emancipation indefinitely adjourned. Reciprocal regard plays no part in schemes organized on this basis. Enforced industrial serfdom is the real object.

The establishment of liberal agencies of social welfare must be placed on an entirely different plane. It so happens that philanthropy may be applied to industry on a satisfactory economic basis. Money may not be made directly out of every enterprise but there is none the less a distinct and positive return. The *sine qua non* of voluntary patronage, if I may so call it, is that the essential freedom of employés be respected. Wherever there is mutual contribution the principle of joint management must be effectively recognized. This is the sort of patronage which is really potent and it is the kind which now prevails most largely in continental Europe, particularly in France and Belgium. Professor E. Cheysson, of Paris, recently published an interesting table of expenditures in a single year by ten of the largest coal-mining companies of France for the welfare of their help. The sums do not vary materially from year to year and are considered fixed charges. The following statement presents the facts:

NAME OF COMPANY.	Expenditures.		Per cent. of expenditures of total wages paid.
	Total.	Per workman.	
Roche-la-Molière et Firminy	$ 44,829.20	$16.60	7
Montrambert	41,600.00	19.00	8
Courrières	73,678.80	20.80	9
Bességes.................	69,147.20	29.80	11
Auzin....................	313,551.40	27.20	12
Douchy	42,270.40	31.00	13
Liévin	68,344.00	31.00	15
Lens.....................	164,200.00	31.00	15
Béthune..................	100,000.00	32.60	16
Blanzy	223,759.00	43.20	20

In one instance the sums thus spent amounted to 70 per cent., and for half the companies they amounted to more than 40 per cent. of the dividends paid to shareholders. Analyzing the outgo of the Blanzy corporation which is relatively the largest, we find that the subsidies accorded to the workmen's mutual aid society was $28,944.93; to the pension fund, $22,122.01; for medical attendance, medicines and hospital, $8059.03; to kindergartens, primary and apprenticeship schools, $34,923.43; advances of money made without interest, $2081.20; to bureau of public relief, $7690.72; for workmen's dwellings—interest, taxes, insurance and repairs (the gross rentals are fixed at 1⅓ per cent. of cost price), $37,071.89; annual loss of interest on money invested in mill and bakery, to furnish bread at cost price, $1747.86; value of coal furnished to workmen for domestic use, $63,955.30; to eleven musical and recreative societies, $3473.73; to sundry objects, including church, library, lectures and baths, $13,688.88.

French mining corporations do not stand alone in this phase of philanthropy. The railway companies contribute sums varying from 15 to 20 per cent. of their wage disbursements each year. The glass-factory at Baccarat accords subsidies equal in value to more than 2 per cent. of the capital stock and the ancient establishment at St. Gobain $16.40 annually for each employé. The great iron and steel works at Creusot sets aside annually $326,400 for the benefit of its 12,338 employés, and the far-famed chocolate establishment of M. Menier at Noisiel, over $10,000 for its 1500 workmen, besides paying 6 per cent. interest on deposits in the savings-bank, the deposits averaging over $400,000 at the end of each year. The chemical works of Solwoy & Co., at Dombasle, support a peculiarly imposing array of institutions of welfare, as do the cotton-printing establishment at Thaon, the textile factory of D. Water-Seitz at Granges, and many other industrial enterprises in different parts of France.

In Belgium and Germany the zinc works "Vieille-Montagne," the Krupp establishment at Essen, the textile factory of D. Peters & Co. at Neviges, and the industrial societies of Mulhouse and Verviers deserve particular mention. In the first-named, special attention has been paid to thrift, the creation of mutual-relief and old-age pension funds and to facilitate proprietorship of homes among workingmen. Five per cent. interest is paid upon nearly $400,000 of savings deposits; $15,000 a year on the average during twenty years have been expended for pensions, and to-day one workman out of every six in the company's employ is the owner of the house in which he lives. The beneficiary agencies at Essen, involving an enormous annual outlay, are too well known to justify describing anew. Associated industrial effort at Lyons, Mulhouse and Verviers has likewise accomplished desirable ameliorations in the condition of local wage-earners.

Mulhouse is the place where free industrial patronage originated. In 1835, M. André Koechlin, a well-known manufacturer, built near his factory thirty-six dwellings containing each two rooms and a kitchen, besides a garret, cellar and garden. They were rented to employés at extremely moderate rates upon the condition that tenants should cultivate their own gardens, would send their children to school, make a weekly deposit in the savings-bank and contribute three cents weekly to a mutual-relief fund. The beginnings of the system are thus closely associated with the amelioration of the workingman's home. Elsewhere large developments have taken place along the same lines. Investments for this purpose in important industrial centers often amount to hundreds of thousands of dollars, while sums equally generous have been advanced without interest to trustworthy employés so that they might build their own houses. Rents are always fixed at lower rates than for fairly similar accommodation in the neighborhood. Often there is such disparity that the direct, net returns to proprietors are not more than 1 or 1½ per cent.; seldom do they exceed 3 per cent. Oppressive regulations of tenancy entailing immediate ejectment in case the occupant goes on strike or quits the service of the employer rarely exist and, in the majority of instances, the houses may be purchased on long-term payments. Reversion to the original proprietor at current market rates is usually stipulated, should the owner sell out.

For ten years past the progress of private industrial philanthropy in

Germany has been slow. Change of policy on the part of the government after the issue of the late Emperor William's famous rescripts of 1881, and the growth of social democracy are responsible causes. Socialism thrives best on discontent, and a stable and well-ordered industrial population does not furnish good material for converts. Once imbued, however, with the doctrine, the laborer is taught to look askance at most agencies for promoting his welfare designed and carried on by private sources. Indeed, his instructors generally teach him to regard them only as cunningly devised bonds of servitude. The imposition of compulsory accident, sickness, and old-age insurance, even more than the growth of social democratic sentiment, has militated against the progress of private effort. The charges imposed for these purposes are so heavy that none but very wealthy concerns are able to maintain additional philanthropic agencies. I do not assume to say that the working masses as a whole have not gained by the change. I think they have, for while under the old system, a comparatively small number benefitted, universal insurance carries at least a part of the advantages to all.

On the continent we see two distinct ideas embodied in practice. The first represents human regard, spontaneous in its activity but lacking in universality. The second stands for compulsory beneficence, covering a limited range of subjects but so far as it goes broadly inclusive. There is still a third, and upon it the policy of Great Britain and the United States reposes. Almost absolute non-intervention in the private interests of the wage-earner is the principle referred to.

Each one of these three systems ot industrial policy has its advantages and its drawbacks. Can a combination be formed which will work well in America? I am optimist enough to believe it to be possible. The character of our government and our industrial traditions are such that the German idea is not now applicable. I would not be surprised if compulsory labor insurance yet made the tour of the civilized world; still I think its coming to our shores will be long deferred. The combination I would suggest may be made by retaining our respect for the personal rights of employés to improve their own social condition, but to borrow so much of the continental practice as relates to affording them spontaneous help in this direction. I know I shall be told that paternalism has been tried in the United States and has failed. It deserved to fail! I am arguing not for paternalism, but for enlightened human regard. The patriarchal spirit does not dominate those agencies of welfare in continental Europe which have been already described. Participation is as voluntary as the provision is free from unworthy motive.

The mistake has been made in this country of so often attaching compulsory or semi-compulsory conditions. You cannot make people sober, honest, or virtuous by legal enactment; no more can you directly or evasively require them to consider their own economic interests. Insisting on your operatives keeping your houses full so that your 6-per cent. rent roll may be intact, or compelling employés of railway corporations to contribute to relief funds, is from the sociological standpoint a woeful blunder. The American temperament unfailingly resents such things, and when self-assertiveness is flanked by ignorance the effects are worse. Absolute freedom alone can disarm suspicion, ignorance must disappear with objective enlightenment and intelligent appreciation will ultimately displace indifference.

It is quite proper to inquire into the motive which dictates the establishment of agencies of social improvement by continental manufacturers. Has it been purely disinterested? Is the welfare of operatives the sole object? No; social helps are a means to an end in which resides advantage to both parties. Money spent upon them brings a larger economic return than under ordinary factory methods. I do not mean so far to impugn the motives of generous employers as to insinuate that self-interest is the only motive, but I do believe that it has been a powerful incentive. Experience has taught them that industrial philanthropy wisely conceived and administered is bound to pay and they have seized hold of the abiding truth that ethical elements play a large part in economic activity. M. Aynard, one of the industrial princes of Lyons exposes the creed of this type of manufacturer when he says:

> It is an error to suppose that in social economics we can be satisfied with simple justice; that is to say, with a strict observance of what are called inexorable economic laws. . . . . These laws are only the results of experience and observation which have shown them to be the best means of developing and fructifying the field of labor. They are not inviolable in the same sense as the great physical laws of nature. If they are founded upon nature we may say what Bacon said of art, in order to apply them, "man must add himself to nature." To employ a man and a machine are two things eternally distinct in the eyes of the moral law. No fatalistic or natural and especially no economic law can justify an employer in not fulfilling his whole duty towards his help.

The economic reward comes chiefly from added efficiency and stability to labor. The élite among workingmen everywhere are endowed with ambition. We are prone to consider this too exclusively as a feature of American life. It exists in Europe as well, and in no small degree. It is in the possibility of satisfying ambitions where our advantage lies. Extended observation has shown me that the better element among workingmen is always ready to go where the best opportunity exists for realizing social aspirations. More than this, when once so situated they stay. Now labor is not everything, but it is the determining factor in industrial success. Supply of capital and good business management count for much, but labor counts also. Stability of the working population is a powerful factor in the industrial prosperity of a nation. We see its effects in the existence of such centers as Mulhouse, Lyons, Roubaix, Geneva, Leipsic, Essen, Creusot, and other places where inherited skill guarantees continued ascendancy. Stability in these days of facile transportation and awakening democracy presupposes fair wages and favorable environment, it by no means connotes industrial serfdom. Experience shows us also that out of the ranks of employés of one generation come many a superintendent and employer in the next. "In Europe?" I can imagine some one saying. Yes, in Europe. I have personally come across a host of such cases. Ambition and skill can everywhere create industrial opportunity and utilize it to advantage.

We must make a distinction between stability of labor and immobility of labor. The first is voluntary, the second involuntary. The former refers to the highest class, the latter to the lower masses. Because immobility is from force of circumstances such as inferior intelligence, low standard of existence, lack of organization and the pressure of over-population more characteristic of the old world than of the new, popular opinion is grounded on false inferences. In an exaggerated fear of enthralment American workingmen, have, speaking generally, become far too migratory for their own good and for that of their employers. Such practices explain why, with immensely higher earnings, savings are relatively less. They militate especially against national opportunity to establish a reputation in the higher and finer grades of manufacture.

Stability of labor is favorably affected by an employer exercising a wholesome interest in the social improvement of his help. This fact is proved beyond question by the experience of some of the important continental establishments already mentioned. At Blanzy, out of 5182 work people, over 20 per cent. have been in the employ of the corporation for over twenty years. Nearly 6 per cent. have seen more than thirty years of service. At Creusot, 4061 out of 12,338 helpers have been continuously employed for over twenty years, 2851 for over twenty-five years and 1491 for more than thirty years. At St. Gobain and Chauny 46 per cent. of the 2234 employés have had their names on the pay-roll for over ten years and 10 per cent. for over thirty years. The director-general of the "Vieille Montagne" company which has its mines and zinc foundries in Belgium, France, Germany, and Sweden, sums up in an interesting way the results of his administrative policy:

> First of all, from the social point of view have we obtained harmony, amongst all who by their labor coöperate in the common work, have we realized that ideal social

peace of which economists and statesmen dream? We dare not affirm that perfect order has been definitely created and that our helpers have already attained that degree of moral superiority. What we can show is that up to the present, notwithstanding the diversity of countries and the variety of industries *we have never had a strike* and that a remarkable stability of labor has been attained. The average duration of employment for 6500 men is over twelve years. These facts find their natural explanation in the advantages accorded to the working people—good wages, participation in industrial benefits, facilities for thrift and the acquisition of property, security for the future through the establishment of sick-funds and a pension system. Over 900 depositors in the savings-banks, over 1000 working men living in their own houses,—a contingent of the élite wedded to the cause of order, of labor and of peace—these are the consequences! But it is very important to state also that money spent in this way has in no wise detracted from the financial prosperity of the company. If the "Vieille Montagne" corporation has been able to give its shareholders annually a dividend of 20 per cent. on the value of their original investments . . . . the credit for this is due to the liberality with which the management has treated workers of every grade.

The workingman's fear of industrial anchorage is a grave mistake. Stability is an important element in his personal welfare. Frequent changes of employment encourage restless, roving habits and involve a serious waste of gainful opportunity. They check the acquisition of a modest patrimony which is the basis of social betterment. In times of financial depression the difference between the two classes of laborers is made strikingly apparent. The settled employé with his little hoard is able generally to tide over the interim and is gladly received into the factory on the earliest resumption of work. The other class at best subsist and are compelled after each move practically to start life anew. There need be no fear of economic slavery. American workingmen are sufficiently well organized and jealous of their *amour propre* to render abortive any attempt to create industrial serfdom. So also is compulsion, whether mild or arbitrary, foredoomed to failure, while spurious philanthropy is easily detected and receives its just deserts.

But if the workingman's interest lies along the line of stability the employer's does also in even greater degree. A well-paid, contented, socially ambitious body of laboring people is *the* effectual guarantee of prosperity. Every incentive to skill, every avenue of improvement, every bond of attachment which can be created redound to the mutual benefit of work-provider and wage-earner. The principle of spontaneous patronal intervention is a good one, but practical efforts will surely be impotent unless based on human regard and fellowship. They must be free from the slightest taint of charity and be limited by the boundaries of the Golden Rule. The conditions of industrial activity differ greatly in America and Europe. We cannot feel sure that what works well over sea can be effectively reproduced on this side. Still that is no valid agument against a trial.

HISTORICAL ARCHITECTURE IN CURRENT USE.

By Prof. Wm. Henry Goodyear.

THE object of this paper is to call attention to a fact in the history of modern architectural styles which is constantly overlooked by architects, as not being historians and generally ignored by historians, as not being architects. This fact has a bearing of great importance on the problems of modern taste in architecture—both on the problem of its possible improvement and of its actually rather chaotic condition at present writing. The fact to which I allude is that the modern conception of style in architecture as at present ruling taste, has its origin in the history of literature and literary influence. It is not a conception based on the philosophy and history of architecture as such. When this fact has been explicitly made known and its phases explained, the question arises, how far has literary taste a right to govern architecture, and how far does our architecture suffer because literature does govern or has governed it ? I shall address myself to these questions after developing the fact.

The most talented lecturer whom I have ever known (an English coin expert, Professor R. S. Poole, of the British Museum) makes it his openly professed rule "always to lecture to the most ignorant person in his audience." I think we may on the same principle fairly accuse modern taste of any pronounced error which is habitually common to average people. As writers and expounders and would-be prophets of reform we do not address ourselves to the most advanced knowledge, but rather to the more retrograde taste of our day. We cannot expect modern architecture to be lifted to a pitch of perfection by a few men of dazzling genius, or modern taste to be revolutionized by the assertion of correct principles on the part of a few supremely well-equipped critics. I shall therefore feel myself privileged to describe as an error of modern taste at large an error which is very constantly committed by ordinary every-day people. It may or may not be an error constantly committed by architects or one for which they are generally to blame, but it is undoubtedly an error of their average patrons. This error is that of supposing that it is the aim of modern architecture to represent, at least in its more pretentious and important examples, one or other of a series of so-called historic styles.

In my own experience I am constantly asked by every-day people to what "style" this or that building belongs. This question evi-

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dently implies the belief that the building must belong to some style or other. Another question with which I am quite familiar is: "Is such a building correct in style?"—a question which evidently implies the idea that buildings are to be judged by the fidelity with which they copy a style. There are even cases where it appears that the client of an architect is advised that this or that arrangement which the client's wishes call for, must be abandoned because the "style" in which the building has been planned does not allow it. Clearly then the idea of style has a very strong hold on average modern conceptions of modern architecture.

When we take the case of more highly educated critics and of professional experts we meet the same prejudice expressed in a more subtle way. These gentlemen will suavely yield the point that a building is bound to represent its own uses and character and will delicately let you know that they are not absolutely ignorant of the principle of truth in the exhibition of construction, but they will also point out that the experience of centuries is not to be lightly neglected, that according to this experience buildings have fallen into certain types or orders, that the neglect of these types tends to license and encourage extravagant, arbitrary and eccentric designs, and that consequently on the whole it is best to stick to the styles as representing a concrete experience which it is really impossible to materially better. Given such a well-educated defender of the ideal of architectural style for modern building, it may be that when you turn the question to the position of Heine in the Romantic School, it will appear that he does not care for German. If the conversation falls on Byron's relations to the Philhellenic movement it will probably turn out that the well-educated critic prefers Wordsworth. If Milton is the topic he will probably be skeptical of the fact that Paradise Lost is borrowed from a Dutch epic. The well-educated defender of modern architectural styles is not generally very strong on the history of literature. Consequently it is natural that he should ignore the influence of the Romantic School on the modern Gothic, that he should not appreciate the influence of the Philhellenic movement on the revival of Greek architecture and that the relations of the Dutch to the style of Queen Anne should have more or less escaped his notice. Such relations of modern literature to modern architecture I shall briefly mention a little later.

Having tried in my own way to do justice to the opinions of people with whom I disagree, and having said that I consider these opinions to be the dry-rot of modern architectural taste or the cause of its dry-rot, I will proceed to state my own positions as follows:

No style ever has been or ever will be truly revived or copied. To imitate the shape of a historic building is not to revive a style. To imitate the detail of a historic building is not to revive a style. To imitate both shape and detail of a historic building is not to revive a style.

The position of the expert, as just given, who explains why it is best to follow the historic styles is a position taken after the fact. The reasons offered for the action are not the reasons which cause it to be taken, consequently they are not the proper reasons to offer.

The average defender of historic styles in modern architecture is not very keenly alive to the deficiencies of modern architecture when it is defective; he is not very keenly alive to the virtues of a modern building when it has virtues; he is not a very good authority on, or critic of historic architecture.

The most extravagant, arbitrary and eccentric designs in modern architecture are those which pretend to follow the historic styles, not those which deviate from them.

II.

I shall open up my general argument by asking my readers to consider what was the one essential feature of a style in historic architecture, the one fact common to all historic styles. Was it not that nothing else was done at the same time in a different style? At a given time only one style was practiced. When this style was displaced there was undoubtedly a movement of transition, the movement may have begun in one country sooner than it began in another, but this movement was in one given direction. At its close a new style had absolutely displaced the former and the rule of the latter was again supreme as the rule of the former had been.

I shall ask in the next place, By what conditions are our perceptions of the existence of a style determined? The answer is, according to my view, that our perceptions are determined by conditions similar to those which cause us to distinguish between a Caucasian, a Negro, and a Mongolian. The individual variations within each type are infinitely varied, but certain general resemblances so dominate the type that we always recognize it. The difference between architecture and races is that, whereas anthropologists are well agreed that natural causes must have occasioned the difference of race, they are ignorant as to what these natural causes have been. On the other hand, in architecture, we are able to explain the historic conditions by which the historic type and the changes of historic type have been produced in the historic examples. As far as the Greeks are concerned we are able now to specify the modes of evolution in their ornamental forms, the general facts explaining the evolution of their construction, and the general correspondences between their civilization and character and their buildings. We are again clear as to how the Roman came to modify Greek art and as to why he came to adopt it. Once more the history of medieval styles from early Christian to Romanesque and from Romanesque to Gothic is an open book to us. The gradual changes of construction, the original borrowing and gradual evolution of the attendant ornament are again perfectly well understood.

Now what is the difference with the same so-called styles in nineteenth century architecture? First, aside from our continuation of the Renaissance revival of Roman ornament, none of our styles are traditional. There is a complete chasm between the historic examples and the modern copy, covering anywhere from three to twenty-three centuries. Second, no traits of modern character or modern civilization, as such, and no conditions of modern construction can be alleged to explain the cause of revival. Third, the nineteenth century exhibits on one street or during one year a mixed conglomeration of various styles, so-called, whereas in historic examples every other example from the same century or from the same country in the same century would belong to one and the same style.

The above differences may be called general differences between the historic styles and the modern revivals generally and philosophically considered. Are there any differences as regards an individual building?

Let us ask the question first regarding the modern copy of a Greek temple. Will the archæologist of the year 2800 be able to distinguish between the Greek temple of the year 1800 A. D. and the Greek temple of the year 450 B. C.? Undoubtedly he will. First, suppose a ruin in which something of the interior of the 1800 A. D. "temple" is preserved. The interiors of our Greek temple buildings, having been made not for Greek temple worship but for banks, churches and the like, there is not one ghostly resemblance between the modern interior and that which specifies an original Greek ruin. Next, as to exteriors. Leaving out of view the stucco and timber imitations which will have disappeared long before the year 2800, we will suppose the future archæologist fortunate enough to find a real stone imitation of the year 1800 or later. He will look first for vestiges of color and will find none, such as prove that the original Greek temples were decorated in bright colors. He will next look for curves in the main horizontal lines, leans in the perpendiculars, variations in size of apparently corresponding details and in apparently corresponding distances—in fact for the whole delicate system of symmetrophobia which distinguishes the masonry of a Greek temple and he will find none of these things. Finally in place of the copy of the temple form proper, rarely but sometimes found in nineteenth century examples, he will find generally an exterior shape which will prove to him that the building was a museum or a city hall of the nineteenth century and not a temple of the fifth century B. C. Moreover he will find a block distant a contemporary ruin of a Gothic church which by various shams and eccentricities will show him that he has unearthed the ruins of the century of shams and eccentricities, viz.: the nineteenth century.

Suppose for instance that our archæologist should stumble on the ruin of St. Patrick's Cathedral in New York. He will instantly specify its century as against any preceding one by the remains of a cement vaulting. If he should be digging up the remains of Grace Church it is not likely that he will find any remains of a lath and plaster vaulting because that will have entirely decayed, but he will find in the absence of a genuine vaulting a very significant pointer for his period. Finally if he examines the carved details of Grace Church or St. Patrick's Cathedral he will notice them to have the perfunctory, so-much-a-dozen, style of nineteenth century Gothic carvings and his date will be fixed forthwith.

We will next suppose that the archæologist of the future stumbles on a Renaissance revival of Roman style. Here he will be governed first by the use and character of the building. If he should dig up a mansion or dwelling house he will instantly specify the sham by remembering that the Roman never decorated a mansion or a dwelling house by exterior architectural ornaments. The same will hold for a shop. Otherwise the Renaissance period has never built an amphitheatre, a temple, or a basilica, and the type of the building as regards use will determine its period. We will not however assume that our archæologist will be such a mole that he would not at the first glance distinguish the massive power of Roman masonry and the elastic vigor of its decorative detail from the very best imitations ever made after it.

If our assumed archæologist of the future should be comparing nineteenth century Romanesque with the original he would be guided by similar clews. Given a church he would know the nineteenth century example by its not having a vaulting, or by the fact that its stone detail had the appearance of wood carving done in stone. Given a Romanesqe store or a Romanesque sky-scraper he would be controlled by his knowledge that the old Romanesque did not decorate its stores and did not build any sky-scrapers.

I will now proceed to define style as that quality by which we distinguish the counterfeit from the genuine article, and will then return to my assertion that we have no styles in the nineteenth century which are like the historic styles supposed to be copied.

III.

What I am trying to say so far is this—that the whole question of styles in nineteenth century architecture receives altogether too much attention and takes too high a place in our attitude to the subject.

When we compare our own buildings of any so-called style with any supposed original, the resemblances are so slight that they are not worth mentioning, and the differences are so great and so fundamental that the naming by any given style is a most unfortunate misnomer. No doubt we have a style of our own, in the sense in which old centuries had theirs, that is in the sense that to an outsider of any other century our buildings will have general resemblances and general traits by which the outsider will be able to date them. This is all that style amounts to anyway, *as style*. But in so far as we turn out with later judges to have a style it will be one of our own and not some other fellow's, and in just so far all our own pretensions and efforts in the way of imitating other styles will appear as failures and abortions.

The grand difficulty with all the cant about style in modern building is that it relates to details and ornaments, not to whole character and general construction. Go down Broadway and your modern critic will tell you that one insurance building is Renaissance and that another one is Romanesque. The critic of the future will disdain and flout this distinction. He will show you that the detail of both these buildings is essentially alike in lacking effect at a distance, he will show you that in both cases the detail lacks sparkle, imagination, and mystery. He will then lead you to a museum and will show you that these styles of detail were both copied from historic sources and that both were failures in execution because both were copies in design. As between the ornamental details of the various historic styles there is very little to choose, as regards modern use. All had a virtue which the modern copy lacks, and this virtue which all had, is so superior to the virtue which one may have as against another, that the labor of giving a name to the copy is not worth taking, when that virtue disappears.

According to my view the only question worth discussing as between modern styles, so-called, is the question as to which one has the least misapplied ornament and as to which one gives the greatest amount of restful quiet surface and of strong shadow contrast. On these heads modern Romanesque and modern Italian Gothic and so-called Queen Anne are the potential superiors.

Otherwise the only question worth discussing as between modern styles so-called, is the question as to which one exhibits the most vigorous detail. On this head the decision falls the same way in favor of the so-called styles just named, but for a reason of great importance, viz., that these styles, so-called, being the last practiced in our century are the ones on which the general revival of art taste visible at this time has been enabled to display itself.

It appears to me after these remarks that the well-educated advocate of historic styles in modern architecture is a pretended advocate of tradition where none really exists and that he overlooks several points obvious to his opponent. To argue that indifference to historic examples opens the way to eccentricity and extravagance is trying to shut a stable door through which the horse passed a good while ago. To argue in favor of the historic styles is to forget that we fail to reproduce the virtues of any which we copy. The height of absurdity is reached when we take the part of one style as against another. The only question to be asked on this head is: "What part of our century has generally done the best in architecture?" My answer is, in spite of some misgivings, in favor of the latest part of our century. The decision will then fall in favor of the styles, so-called, which happened to be in favor at that time. According to this way of looking at the matter my preference would rest with Romanesque, Italian Gothic, and Queen Anne as having been most done when our taste was at the best. If the question be asked when has Renaissance been done best in our century? I answer, it has never been done very well in our century. Romanesque, Italian Gothic and Queen Anne pretend to be styles but do not pretend very much, therefore they are better than the others which have pretended more.

IV.

My position so far then is this—always antagonizing the well-educated partisan of historic styles in modern architecture—that the appeal to the necessity of tradition in architecture is well put, but that no one wants to dispute it. By tradition we understand continuity, the possibility of change when needed or desired and dependence on the immediately preceding past otherwise.

By tradition I do not understand that of the Greeks or of the Middle Ages. I understand the tradition of 1893 as against 1894, with the possibility of changing that tradition if needed or desired. Now what does the tradition of 1893 show us? Taken in a large sense it shows us a vast amount of historic details of various periods in modern use, all of which may be used as suggestions for a continued modern work and all of which are beautiful according to the talent of the artist who carves them. I will not at all admit that they are beautiful according to the talent of the designer, who stands unhappily behind the artisan of our day as contrasted with the artisan of the past, who was his own designer. As far as detail is concerned there is not the choice of the toss of a copper between Renaissance and Byzantine. The question of detail concerns the talent of the artisan carver. So far then historic styles are not worth debating. The archæologist may be interested in pointing out that the artisan or suggesting designer has gone to this or that source of suggestion, but I cannot conceive that the public is called upon to believe that it has witnessed the revival of a historic style; because nothing of the kind has really taken place. Passing by ornament we will next admit the value of tradition in the matter of construction, but still insisting that in 1894 it is the tradition of 1893 and not that of B. C. 450 or A. D. 1400 which is in question. Now when we come to the matter of construction we have a case for constructors to decide. All authorities agree that the frank exhibition of visible construction and that the ideal or indirect suggestion of invisible construction control the laws of taste in architecture. The question which the well-educated partisan of historic styles has to settle just here, is how far the tradition of 1893 calls for the construction of B. C. 450 or A. D. 1400. We will leave him to agonize over this question and if necessary to write an article about it.

V.

My argument has so far been mainly to show that the supposed differences between different styles in modern use are not worth debating (or naming by the general public)—that the nineteenth century must really have a style of its own of whose character we are just as blissfully unconscious as we are of the reason why an American is always recognized in the streets of London; and whose style or character will be just as certainly visible to future generations as the style of an American is now visible to a European.

But I began this article by saying that the modern conception of style in architecture, as at present ruling taste, has its origin in the history of literature and literary influence. I also noted that the fact is constantly overlooked by architects, because they are not historians and constantly overlooked by historians because they are not architects.

Would it not be well for architects and architectural critics to study a little more closely the causes which have led to the jumble of historic styles which are now being ostensibly reproduced. If the general public could be more widely informed on this point it certainly would tend to shatter their absurd reverence for the modern habit of pretending to reproduce historic style. Let us give a few minutes to laying bare the sequence of events, which has its own logic and which carries its own explanation, when this sequence is observed. It is true that our practice now appears to represent eclecticism when its whole results are considered, but this eclecticism is only the result of a series of overlays of sequent movements, of which the earlier have survived in traditional use while the later have endeavored to supplant them. In the last few years Renaissance has again taken strong hold on fashion and fashionable practice. For its recent revival we may turn partly to mercantile explanations, its showy qualities, and undoubted cosmopolitan availability, partly to the influence of the *École des Beaux Arts* on fashionable American practice; but the essential fact is that Renaissance has never been interrupted or abandoned since it first came into use. It is the earliest of all modern styles and as such has the strongest hold on modern tradition. Its detail has undoubtedly very much improved in quite recent years as against the middle of our century or earlier, but it is essentially the direct perpetuation of the original Italian Renaissance, dating from the fifteenth and sixteenth centuries. Beside this recent continuation of Renaissance we find three so-called styles, all of recent date and all nearly contemporaneous in introduction. Queen Anne or Colonial so called is of course at bottom Renaissance also. As coming into general vogue in this country after 1876 it represents, to my thinking, in city architecture the revolt against the formalism of the earlier brown-stone front Renaissance and in country house architecture the revolt against the carpenter's detail which immediately preceded. The contemporaneous Italian Gothic and Romanesque, first generally practiced in this country after 1870, bring us to the last of a series of reactions and attempted overthrows of the traditional Italian Renaissance.

It must be remembered that the general date for these revivals in Europe will be only a few years earlier.

Italian Gothic and Romanesque were the last phase of the Medieval revival which in its first phase stuck to the Gothic, and this Gothic revival, in its very beginnings, is as recent as the year 1820 or 1825. This Gothic revival was again preceded by the Greek revival which again does not go back of the year 1760 or thereabouts. This was the earliest of the reactions against the traditional Italian Renaissance, whose continued survival down to current date we have first noticed. After this sequence of movements has been noted we shall find our clew to it in the history of modern literature.

Renaissance architecture held exclusive sway in Europe from the close of the sixteenth century till the middle of the eighteenth century because the Italians of the fifteenth and sixteenth centuries were devotees of Virgil and Pliny and the other Latin authors. Is it not a fact that Italian literary interest in Roman antiquity is what created the Renaissance style?

Is it not patent and known of all men, when they give their minds to the subject, that Greek temple architecture had exclusive hold on the best taste of Europe in the fifty years which center about 1800 for a similar reason ; namely that Homer and Herodotus and the Greek authors had usurped the pedestals of the Latin authors ?

Is it not equally certain that Gothic architecture ruled Europe between 1825 and 1850 because historians and philologists had for the first time, turned their attention to this period, because novelists had followed their lead, and because Walter Scott and Goethe had made the Middle Ages fashionable in literature ?

The history of modern architecture is a history of modern literature in its successive revivals and successive dependence on the learning of the Roman, 1500–1760 ; on the learning of the Greeks, 1760–1825 ; on the culture of medieval Europe 1825–1850.

There has been a sequence in historic studies and historic discovery. The latest comers in this sequence are the ancient Orientals, the Egyptians and Assyrians. These nations are now beginning to claim an interest from historians and literary students which before and after 1830, as far as popular interest goes, was reflected in Victor Hugo's "Notre Dame" or Walter Scott's "Ivanhoe" and which then centered on the history and literature of the Middle Ages. This literary movement, known in Germany as that of the Romantic School, is what produced the Gothic revival in architecture. About 1800 men of letters, in like manner, were enthusiasts for the Greek authors and the copies of Greek temples rose to meet this special interest. Before 1760 the Italians of the Renaissance had ruled Europe for two centuries with their own enthusiasms for Roman history and Latin literature and it was this which created the copy of the ornamental system of the Roman ruins.

We return now to our well-educated partisan of historic styles in modern architecture. He is a back number. He belongs to the age of literary influence on architecture without understanding its history, and without knowing that this literary influence upon architecture is dead.

If we were doing in 1890 what we did in 1850, in 1800, or in 1750, we should now be building the Vanderbilt houses like Assyrian palaces and our churches would be copies of Egyptian temples. But we have escaped this absurdity. Literature and history and would-be archæology have lost their hold on architecture, we are still surrounded by fossil survivals of the days of 1850 and 1825, both men and buildings, but these men and these buildings are only fossils. The architect of the future is an engineer.

In a succeeding paper I shall attempt to show how and why he is an engineer, and wherein the architecture of to-day is, or should be, characteristic of our own era.

ELECTRICITY IN THE IRON AND STEEL INDUSTRIES.

By D. Selby-Bigge.

As the science of electricity has become specialized so has the public interest in its applications, and we find ourselves inquiring now—not what has electricity accomplished in its broadest applications, but how has it been adapted to special lines of work? What progress has a given industry made that it owes particularly to the assistance of electricity? What special adaptability have electrical methods to any special line of work? Such inquiries have supplanted the broader ones that preceded them, and as the broader served a useful purpose in building up the science as a whole, so may we expect the more specialized inquiries to result in like benefit in the industries to which they are more particularly directed.

One of the most interesting inquiries of this kind that has yet been publicly presented—one likely to be followed by many others—is contained in a paper recently read by Mr. D. Selby-Bigge.* In this paper he confines himself very naturally to advances made abroad in the direction outlined by the title. On this account it attracted far wider attention abroad than in the United States, but it is of no slight interest to Americans as indicating a means of comparison between foreign and American progress. Much that was said relating to the particular adaptability of electrical methods to the iron and steel industries, while it cannot be claimed to be new, is so tersely and aptly expressed that we have decided to abstract portions that will specially interest readers of this magazine.

Passing over the discussion of long distance transmission of power for the purpose of facilitating the extraction of ore from mines, a suggestion favoring the use of a portion of the waste gases from blast furnaces for the purpose of generating electric currents for this and other purposes, an enumeration of the various classes of machines required in the manufacture of iron and steel, and an allusion to their usual scattered arrangement, the substance of the following remarks are deemed of more especial interest and suggestiveness.—The Editor.

It is a well-known fact that the power actually expended in performing the work on these various machines is a mere fractional part of that transmitted from the generating source. In those cases where the machine tools have been driven by separate engines, it has been a regular practice to provide engines with cylinders sufficiently large to compensate for any possible losses which may occur through leakage, condensation, etc. It seems generally to have been the practice in engineering works to indicate the main driving engines, but during the author's visits to some thirty or forty of the principal engineering works in this country, he has never been able to obtain indicator diagrams showing the power absorbed by steam-driven machine tools in the works. Although attention has been paid to the economy of the main engines, the question of that in the small engines driving these machine tools, and the conveyance of steam, has often been entirely overlooked, and an enormous waste has been going on in this manner for years past.

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* "Electricity as a Motive Power in the Iron and Steel Industries," before a meeting of the Iron and Steel Institute.

With the advent of the electric motor this condition of things was at once changed. Every electric motor may be said to be a self-indicating machine in itself, in that the power which it absorbs can be immediately detected through the readings on the ammeter and voltmeter provided in connection with the motor.

The following are results of experiments that have been recently carried out by the author, in conjunction with Mr. H. Panton, on the actual power absorbed by various machine tools in doing their work. The figures are extremely interesting, as showing the very small amount of power absorbed by the different tools when doing their work.

TABLE OF ELECTRIC MOTOR TESTS TAKEN AT THE WORKS OF MESSRS. DORMAN, LONG & CO., MIDDLESBROUGH.

Description of Machine.	Driven by Engine Capable of Indicating	Replaced by Motor Capable of Indicating	Voltage at Generator.	Voltage at Motor.	Current taken by Motor.	E. H. P. Absorbed in doing Work.
Group of machines as under—	H. P.	H. P.			Amperes.	Per Cent.
Three cold saws …. Two ending machines … One saw sharpening machine	27	10½	120	115	70	10.7
Troughing straightening machine	14	3½	120	118	12	1.9
Double-ended punch, punching four holes one side and one other	14	5	120	115	25	3.7
Straightening machine, all sections	14	3½	120	115	15	2.3
Straightening machine, biggest sections	16	3½	120	115	35	5.4
Cold saw, 26 inches diameter	9	3½	120	110	15–27	2.2 & 3.9

The saving in coal effected on above machine tools amounted to 30 tons per week, after the adoption of the electric system.

Having noted the uneconomical manner—as regards transmission of power—in which iron and steel works, engineering shops, shipbuilding yards, etc., are usually laid out, the power actually lost in transmission through shafting, pulleys and belts, which has often been ascertained to vary between 30 and 69 per cent. of the total power transmitted, and the unavoidable losses through condensation, leaky valves, and joints in long steam pipes, a method is suggested by which these old works could be entirely remodeled so as to effect an enormous saving not only in coal consumption and wages, but in upkeep.

The first thing to be done in planning such a rehabilitation is to have as many engines indicated as possible. Where this cannot be done it would be advisable to lay down a small temporary installation of an engine and dynamo, with a motor which could be transferred from one machine to the other, in order to ascertain accurately the exact power absorbed by the machine in question. In this way an accurate opinion could be formed of the amount of power actually required for operating the different machines throughout the works.

Having arrived at the total horse-power absorbed by all the scattered and outlying machinery, it is advisable to divide this into, say, two units of power. If the total power involved is 1000 horse-power, this would mean that it would be advisable to have two units of 500 horse-power each.

The reason why so large a power is selected as unit is that in electric power installations the load diagram will be found to be of quite a different nature from that of an electric lighting station, which exhibits a more or less constant rise and fall according to the time of day, whilst the load line in an electric power station is of a very different and fluctuating nature, varying at times between a quarter and full load, half load and full load and so on. It is necessary, therefore, both for simplicity in working and for economical reasons, to have a steam dynamo capable of giving out current for at least half the installation. It would be necessary in the case of smaller units to keep them all running, even if the load was only 25 per cent. of the total, in case at any moment the load should suddenly rise. This practice has been adopted in nearly all large power installations on the Continent.

In the case of works where waste furnace gases are available, the evident site for the generating plant would be in close proximity to these furnaces, in order that the boilers of the generating plant might be fired by the waste gases, the cost of the production of the electric current being thereby reduced to a minimum. Should there be no waste furnace gas available, the generating plant should then be placed close to the main battery of boilers in the works, and if these boilers are of a pressure below 80 pounds, it will be found economical to lay down entirely new boilers of say 150 to 180 pounds pressure.

In the case of the remodeled works, the coal consumption would probably be found to be one half or even less, of what it previously was before the adoption of electricity. In all cases where new machinery is ordered for extensions or otherwise in the works, it would be preferable to embody the electric motor in the actual construction of the machine tool itself. In the case of old works, this is hardly feasible, and the next best thing to do is to drive direct by belt on the fly-wheel of the machine in question. The motor itself, in the case of machines having to start up against any sudden or heavy load, should be of the shunt-wound type, with the shunt coils permanently excited off the line.

One of the most important features in connection with electric power installations is the absolute check or control one has over the coal consumption and running expenses at the works; and where possible it is recommended that the circuits from all motors or groups of motors should be taken direct to the generating station, and that on each of these circuits a separate ammeter should be placed, to indicate the exact power taken by any of the machines at any time of the day; as on account of the self-indicating nature of electric motors a most perfect check can be kept on the running expenses of the power plant.

It is quite within the bounds of possibility that electricity may find a new opening in its application to driving the lighter class of rolling-mills. The result, as far as economy in steam consumption is concerned, would show a great saving on methods formerly employed. The saving would be arrived at in the following manner:—Instead of the present form of engine used for actuating the rollers which is necessarily of a somewhat uneconomical nature owing to the work it has to perform, and in which the cut-off is of a very imperfect character, an engine could be laid down on the most highly economical principles, working at a high pressure, with three expansions of steam, and taking not more than 1½ pounds of coal per horse-power per hour. This engine would be coupled direct to a dynamo of suitable power, and the steam dynamo generator would be kept running continuously. On each set of rollers would be directly coupled an electric motor. The switching apparatus would be worked by means of hand and foot levers, almost in identically the same manner in which the steam is shut on and off existing rolling mill engines.

An electric motor may be considered as an elastic coupling in itself, and provided that the power furnished to it is sufficient, it will revolve when the necessary torque has been obtained. The jar, however, would be furthermore reduced by mechanical methods of coupling, and no difficulty is anticipated in being able to obtain a motor which would resist such strains as would be put upon it. The switching apparatus, however, would require carefully planning out and constructing, in order to withstand the rushes of current which would take place through the apparatus; but here again there is nothing that cannot be overcome.

Under the heading "Engineering Works and Shipbuilding Yards," a table calculated by Mr. Felix Melotte is presented showing a very interesting comparison between the efficiencies, *obtained* on a varying load, of electrical and mechanical transmission of power.

Electrical Transmission—						
Load on the engine	1000	750	500	333	250	200
Constant frictional loss	50	50	50	50	50	50
Variable electrical loss	50	27	11	4.5	2.2	1.2
Total loss in dynamo	100	77	61	54 5	52.2	51.2
Available power of dynamo	900	673	439	278.5	197.8	148.8
Efficiency, per cent	90	89.7	87.8	83.5	79 1	74.4
Loss in conductors	18	10	4	1.7	0.8	0.5
Energy available at motor terminals	882	663	435	276.8	197	148.3
Of which, 6 per cent. frictional loss	53	53	53	53	53	53
4 per cent. variable loss	35	20	8.5	3 4	1.7	51
Total loss in motor	88	73	61.5	56 4	54.7	54
Power available	794	590	373.5	220.4	142.3	94 5
Final efficiency, per cent	79.4	78.7	74.7	66.2	57	47.2
Mechanical Transmission—						
Load on engine	1000	750	500	333	250	200
Loss in shafting, etc	206	206	206	206	206	206
Useful effect	794	544	294	127	44	0
Final efficiency, per cent	79.4	72.5	58.8	38.1	17.6	0

From this table it will be seen that the two systems of transmission, which at first appear to be equivalent, become very different as the load diminishes. Thus, when only one-fifth of the power is developed, electrical transmission still yields 47.2 per cent., whilst mechanical transmission has had all its power absorbed in the constant frictional loss of 206 horse-power.

In ship-building yards there are few machines that cannot be run electrically. The whole of the machinery usually found in the machine sheds, such as punching, shearing, bending machines, etc., saws, woodworking machinery, can all very easily be run by electric motors. Owing to their light and portable nature, there is a considerable opening for electric machines on board ships during construction. Electric power can be utilized with advantage for the drilling of ships' plates, temporary winch and derrick crane work. The author understands that it has also been successfully applied for planing wooden decks.

Results obtained in actual operation of electric power installations carried out in Belgium which have now been running some three years, cases in which the entire works have been actuated solely by electric power, are instructive in this connection. "One of the first, and perhaps most important, electric power installations that has been laid down in that country, is that of the National Arm Factory at

Herstal, near Liège. The plant in the first instance consisted of a 500 horse-power compound Corliss engine and multipolar dynamo combined, the armature acting as fly-wheel of the engine. The Arms Factory is solely and entirely driven by electricity derived from this one dynamo, which provides at the same time the whole means of illuminating the works. Some 2000 hands are employed, and have been dependent for over two years on the running of this one dynamo. There has been no stoppage from the day of starting the installation up till the present time. About nine months ago another 300 horse-power was put in. This, however, was not to act as reserve power, but to supply power for extensions which had been made to the factory. The steam consumption of the engine is 13 pounds of steam per indicated horse-power. The total efficiency, reckoning from the indicated horse-power of the engine, has proved itself to be 71.3 per cent.

"Following the example of the National Arm Factory, the Belgian government decided to remove all the steam-engines and boilers from the Royal Arm Factory at Liège, and to replace them by electric distribution. It was ascertained that for a certain portion of the work which, previous to the introduction of electric driving, had taken 3 tons of coal per day, this was found to have immediately come down to 900 kilograms, or less than 1 ton, for the same amount of work done."

Taking into consideration all that has been stated, it will be seen that electric power is destined in the near future to become an important factor in the iron, steel, and engineering trades. Whether applied for the purpose of long distance transmission at the mines, or for short distance transmission and concentration of power at works, great economy will be realized in wages, fuel, and upkeep, over methods hitherto employed. Old works can be remodeled with advantage, as shown in the cases of the Royal Arm Factory and the Veille Montagne Zinc Works in Belgium, and the case of Messrs. Dorman, Long & Co.'s Steel Works at Middlesbrough, and what possibilities lie open to those contemplating laying down entirely new works!

While it is probable that there is no one establishment in the United States comparable in size with the Royal and National Arm Factories now employing electricity exclusively as a motive power, it is also probable that electricity has been more generally applied here in the iron and steel industry than abroad.

In regard to the application of the electric motor to rolling mills we are likely to see Mr. Selby-Bigge's prediction verified very shortly if it has not been already. As this application is unique, it may be well to mention it here. The installation referred to consists of a 30 K. W. motor connected direct to the rolls, the specifications requiring that it shall be capable of reversing under full load every 10 seconds. No simple shunt wound motor could meet this requirement, but the contractors feel confident that the Leonard system, upon which they are relying, will enable them to meet every demand.

Reference to electrical metal working is conspicuous by its absence in Mr. Selby-Bigge's paper. It is true that this does not properly come under the head of "electricity as a motive power," but it plays such an important part in the iron and steel industry in America, that it must needs be mentioned in this connection. In this country there are being made at this time 2,700,000 welds per annum on steel and iron wire in the utilization of shorts. On iron pipe for refrigerators, ice machinery, etc., the work done is at the rate of 360,000 welds per annum ; on axles, tires and hub-bands, 144,000 welds ; carriage hardware, 275,000 welds ; agricultural machinery (mostly wheels), 720,000 welds ; railway construction work (frogs, switches, etc.), 150,000 ; and on copper and brass wires (from No. ½ to No. 16 A. G.) about 3,780,000 welds. The aggregate power employed, as above, is 4000 horse-power. In addition to this, 200 horse-power is employed in the U. S. navy yards for welding purposes, and 250 horse-power for the production of electrically welded projectiles used by both army and navy.

Electric traveling cranes have come into such general use as no longer to excite remark and they have been constructed in sizes far larger than any employed abroad. For instance the English electrical journals recently described the completion of a 60-ton electric crane at the Seraing Works of the John Cockerill Co., Belgium, as probably the largest in the world. There are quite a number larger than this in use in this country, two of which—75 and 150 tons—are at the Watervliet arsenal.

We also have put into successful practice the direct application of the motor to the tool as recommended by Mr. Selby-Bigge. Noteworthy examples of this are found in the universal drilling machines in the Cramps shipyard and in the Southwark Foundry.

In our rolling mills electricity is all but universally used for illuminating purposes, and has also found many applications as a motive power. For instance, in the Homestead mills the cranes used for handling and transferring ingots as they come from the furnace are operated by electric motors, and at the Edgar Thomson Steel Works the ingots are charged into the soaking pits by the same agency.

In the navy yards the following installations have been made :

Washington, D. C., Navy yard, 100 K. W. for arc lighting and electric crane. Mare Island Navy yard, 140 K.W. for arc and incandescent lighting. Norfolk, Va., Navy yard, 280 K. W. for arc and incandescent lighting, motor service and electric welding. And there is at present under contract for the Boston navy yard, 120 K. W. for arc and incandescent lighting, and for League Island navy yard, 60 K. W. for arc and incandescent lighting, making a total for the United States navy yards of 900 K. W.

In the United States navy the total electrical capacity actually installed in all of the vessels to date is 1470 K. W., chiefly employed in incandescent lighting apparatus, for hoisting ammunition, and for search lights. One ship, the *New York*, has been supplied with an electric launch, and several ships have been equipped with the Fiske electric range finder for ascertaining ranges.

Experiments are however being conducted with a view to a much more extensive application of electric power on board-ship as a substitute for steam for elevating guns, operating ventilating fans, and last, but not least, for revolving turrets. This latter application is considered the most difficult, and so far as the Bureau of Ordnance is aware has not been attempted elsewhere than in the experiments recently tried by them at Philadelphia.

Thus while we probably find the application of electricity in the iron and steel industry in the United States nowhere quite so complete as in the instances cited by Mr. Selby-Bigge, we find it making enormous strides in every direction, having made some important conquests here that it has not made abroad.—THE EDITOR.

THE ARMOR-PLATE QUESTION—1894.

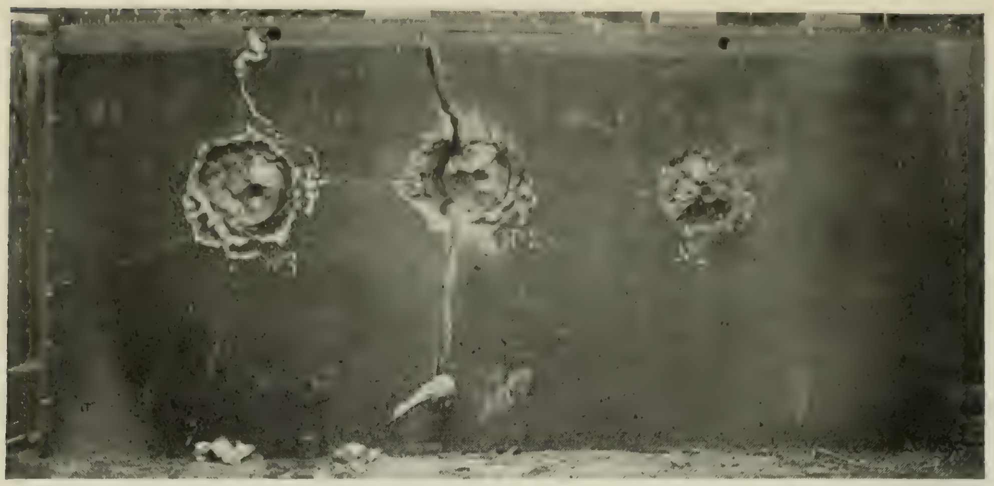
By Captain W. H. Jaques.

EXPERIMENTATION, criticism, competition and rivalry have caused a development in the armor-plate industry of unusual rapidity and energy. To such an extent, in fact, that a book could easily be written on what has occurred within the last twelve months in the United States alone, while our successes here have spurred the foreign makers and governments to an interest in this question they have never displayed before. While it is impossible in a magazine article to illustrate or describe all the results of the service and experimental tests that have taken place since the publication of Ensign Dashiell's article in THE ENGINEERING MAGAZINE for September, 1893, a sufficient number of illustrations have been collected to give the general reader an idea of the progress in armor production and to present information that will be of use to the technical student.

The British makers have given up the compound type to which they so tenaciously held, and all the European manufacturers of armor have adopted the the carbonized all-steel, using more or less carbonization or surface hardening in accordance with their own special views, and employing a variety of methods to secure the surface hardening. Great Britain has acknowledged our supremacy in the armor question and partially imitated our methods ; but, for some reason not yet publicly explained, the employment of nickel in armor has been officially announced as an unnecessary increase in the cost of its production. Considering the benefits that its use has demonstrated in steel for many other purposes as well as armor, it is difficult to accept this decision on the part of the British admiralty.

The review of the past two years shows wonderful progress in this country and up to the time when I severed my connection with the Bethlehem Company that corporation had succeeded in obtaining the best record. Although statements may be repeated here, they have been employed to complete the description of the situation at the end of the year 1894. A few plates remain to be tested which may throw additional light upon some of the complex questions, but it is not probable that any more very thick armor will be tried before 1895.

The tests which have excited the most interest and carried with them the most commercial risk were the 17-inch and 18-inch nickel-steel carbonized armor for the battle-ships. Two 18-inch plates from Bethlehem, one 17-inch from the same company and one 17-inch from the Carnegie Company have been submitted, two passing test under



A. Bethlehem 2d 18-in. N-Steel Carbonized, "Indiana's" Side Armor.

the narrowest margin, and the other two failing. One of the latter, the Carnegie 17-inch, has been accepted because of its good behavior under subsequent severe trial. All were tested with 12-inch armor-piercing projectiles. Bethlehem's first 18-inch was a taper plate* for the side armor of the *Indiana*. It was hammer-forged, sixteen feet long, 90 inches wide and 18 inches thick for 4 feet of its width from the top, tapering thence to 8 inches at the bottom edge. It weighed 33.7 tons. The plate failed under the first shot from a 12-inch pro-

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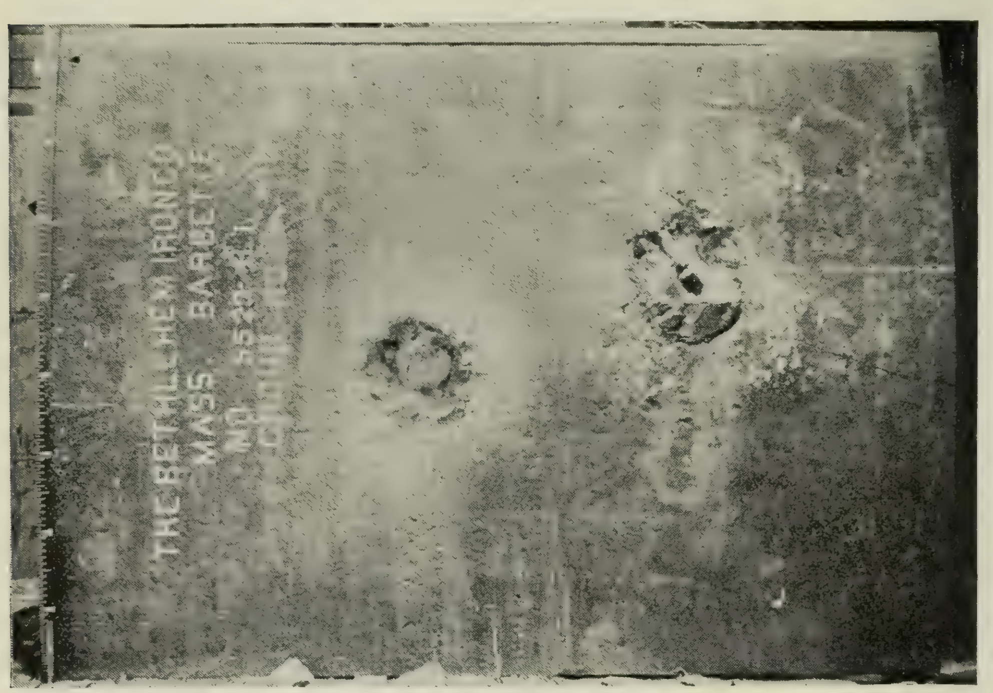
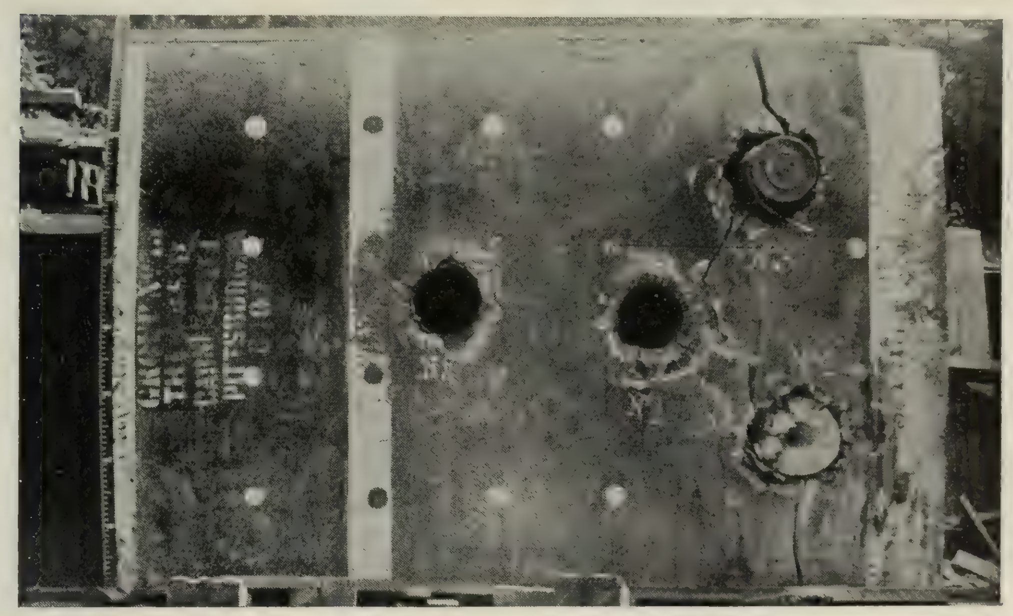
* The *Engineering and Mining Journal* in its issue of May 26, 1894, gave an illustrated description of the test of this plate.



B. Bethlehem 17-in. N-Steel Carbonized, "Massachusetts" Barbettes.

jectile having a striking energy of 12,660 foot tons. The failure was due to a crack caused or developed by the Harvey treatment. The second 18-inch plate *A* barely passed the required test, the second shot cracking it seriously, although the projectile did not get through the backing. Bethlehem's 17-inch plate *B* passed the requirements; but, as usual, the plate cracked.

The Carnegie 17-inch plate did not fare so well, the narrow margin being overcome by an exceptionally good Wheeler-Sterling projectile getting through plate and backing at the second shot. The plate stood up so well after it had been subjected to the attack of two more 12-inch shells *C* that the lot it represented was accepted, and subseqently three 10-inch experimental Midvale-Holtzer (2) armor-piercing and Johnson (1) steel cast shells fired against it increased the cracks, but no portion of it left the backing *D*.

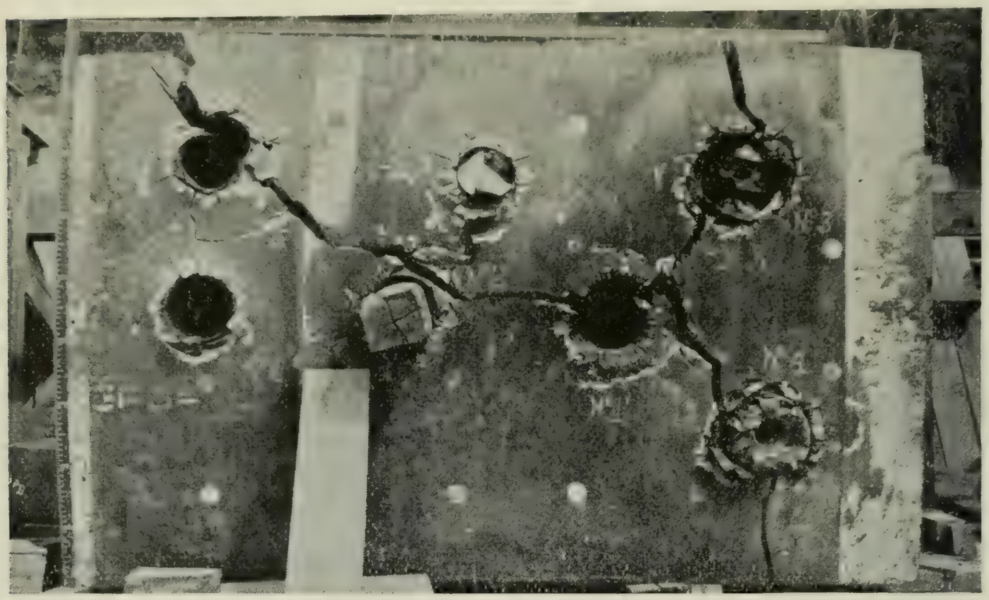


C. Carnegie 17-in. N-Steel Carbonized, "Oregon's" Barbettes.

The *Texel* trials (international) of 5.9-inch plates; the *Nettle* trials (British) of 6-inch plates, which decided the Admiralty to abandon the use of nickel; the Gavre trials of December, 1893, with 6-inch and 10-inch armor; and some experimental work at Ochta, Pola, Shoeburyness, Meppen and Witkowitz with plates varying in thickness from 6 inches to 14 inches, constitute the principal experimental work abroad. Of these, the only thick plates were presented by Vickers—12 and 14-inch—both of which cracked badly, the latter being completely perforated in addition when attacked with velocities of 1772 and 2050 foot-seconds with a 926-pounds steel projectile from the 13.4-inch B. L. rifle.

The armor exhibit at the World's Columbian Exposition at Chicago, 1893, was a valuable one, although all the makers were not represented. In addition to Bethlehem's extensive exhibit, which was installed by the writer, Krupp, of Essen, and John Brown & Co., of Sheffield, exhibited compound and steel plates of thicknesses varying from 10 to 16 inches. Schneider exhibited only a fac-simile of the celebrated nickel-steel plate which won the victory at the Annapolis tests of 1890 and some hardened gun shields, together with a very comprehensive exhibit of armor bolts and their accessories. The table on page 414 gives details of the manufacture and ballistic resistance of the three most resisting plates exhibited.

As far as the most resisting individual thick plate is concerned the nickel-steel carbonized armor is undoubtedly the best, and experiments on both continents show conclusively that the employment of nickel in steel is not only of great benefit to armor but also to steel used for many other war and commercial purposes; and this notwithstanding the conclusions of the British admiralty that:



D. Same as *C* After Additional Tests.

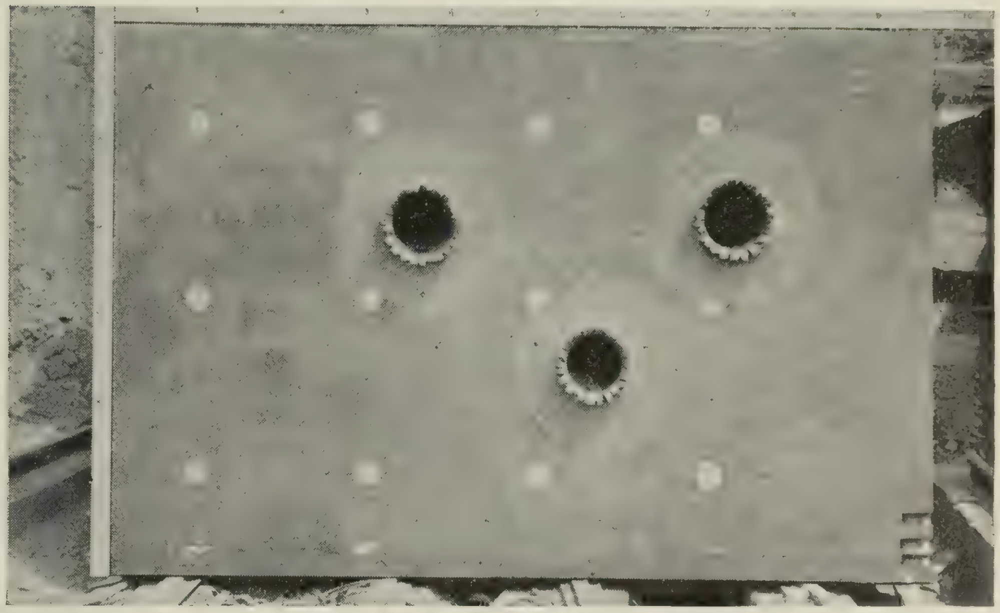
"In the course of the experiments the use of nickel as an alloy of steel for the purposes of armor plates has been fully tested. It has been established that Harveyed plates without nickel in the steel show resistance to modern projectiles as great as any hitherto obtained when nickel was combined with steel in plates also treated by the Harvey process. The consequence of adopting this new system will be a great saving in cost for a given defense."

And of Captain Orde Browne that:

"We [Great Britain] have also reason to believe that we have obtained certain distinct advantages in discarding nickel in the case of Harveyed plates. In England it has been decided not to use nickel in Harveyed plates because the resisting power against penetration is greater without nickel, although toughness is less."

The attempts to demonstrate the value of nickel in steel have been very unfortunate in England and the question naturally arises why is nickel steel so expensive as to preclude its use there? The United States steel workers have had better success with nickel than even French makers, although to Mr. Schneider, of France, belongs the credit of introducing nickel in steel.

The two facts mentioned by Mr. Ellis, managing director of Messrs. John Brown & Co., Sheffield, in his paper on "Recent Experiments in Armor," read before the Institution of Naval Architects, March 15th last, that "the presence of nickel causes steel to crystalize at a much lower temperature than it would otherwise," and that "the arc-light system of drilling is not applicable to plates containing a high percentage of carbon and nickel together," have, in no way interfered with our producing thick plates of carbonized nickel steel of a most attractive fine grain and fitted with as many holes and bevels on the hardened face and edges as the most exacting sailor or cabinet-maker could ask for. Further the practical evidence which the Krupp, St. Chamond, and Bethlehem 8-inch to 17-inch plates furnished as to the value of nickel in steel armor must carry great weight. Figures *E* and *F* show the remarkably uniform results that can be ob-



E. Carnegie 9-in. N-Steel, "Monadnock's" Side Armor.

PLATES.

No.	Type.	Manufactured by	Country.	Dimensions.			Weight tons.	Remarks.
				Length feet.	Width feet.	Thick inches.		
1	Nickel Steel Carbonized.	The Bethlehem Iron Co.	United States.	8	6	10½	9.35	3¼% nickel, medium carbon, carbonized, water chilled steel.
2	Iron & Steel Compound hard'ned, Tresidder Pr'cess	John Brown & Co. Atlas Works, Sheffield.	Great Britain.	8	6	10	8.56	⅔ iron back, ⅓ steel face, Tressider water cooled, compound iron and steel.
3	Nickel Steel Carbonized.	Krupp.	Germany.	8	6	10¼	9.06	Nickel steel, medium carbon gas (?) hardened, water chilled steel.

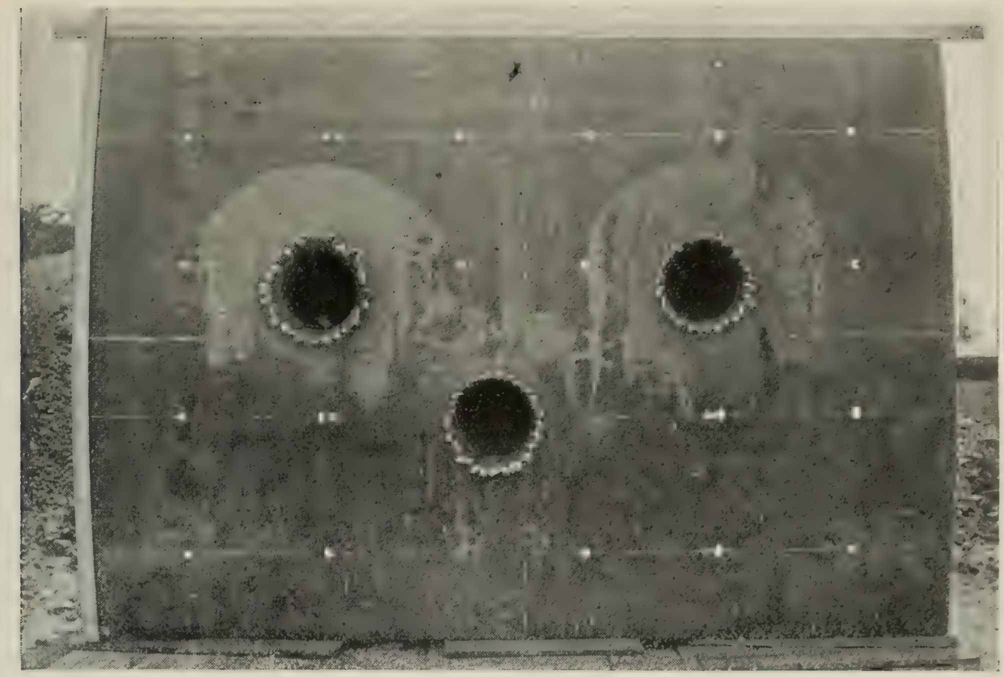
BALLISTIC TEST.

No.	Trial.		Calibre of gun inches.	Numb'r of shots.	Projectile.				Plate.			
											Energy.	
	Date.	Place.			Type.	Weight lbs.	Striking velocity ft.-sec.	Effect on.	Penetration inches.	Cracks.	Ft. tns. per tn. of plate.	Total ft.-tons.
1	July 30, 1892.	Bethlehem's Proving Ground.	8	5	Holtzer	250	1700	Points welded in plate broken into small pieces.	11.7	One slight.	542.5‡	25040
2	Aug. 4, 1892.	Shoeburyness.	6	5	Holtzer	100.7	1950	Broken into small pieces.	9.95	None.	310.1‡	13272
3	Mar. 13, 1893.	Meppen.	5.9 8.26	3 2	Krupp	112.4 307.5	2160* 1824†	Points welded in plate broken into small pieces.	12.2 ...	None.	783‡	20957

* 3 shots :—1886, 2000, 2160 ft.-secs.

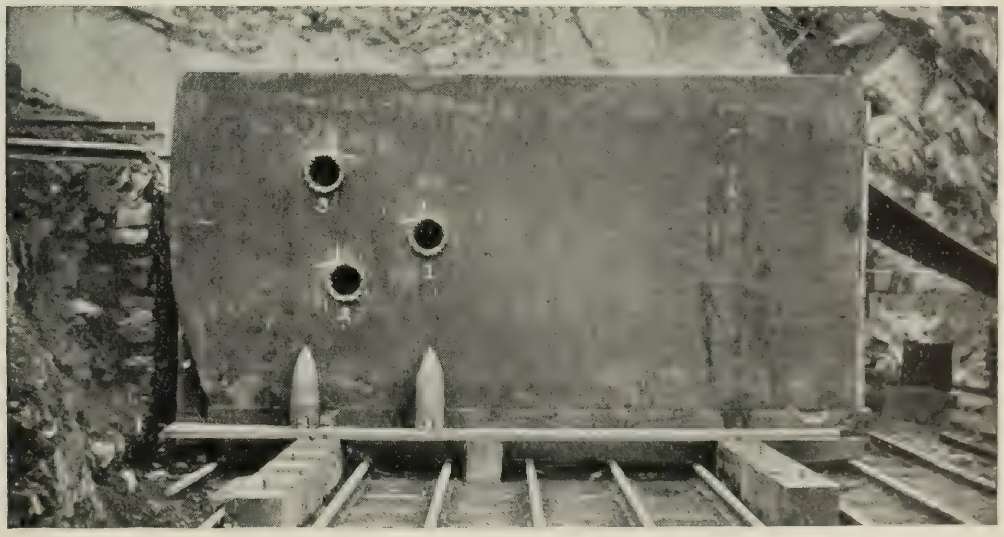
† 2 shots :—1728, 1824 ft.-secs.

‡ Single shot ; Krupp case, one of highest energy.

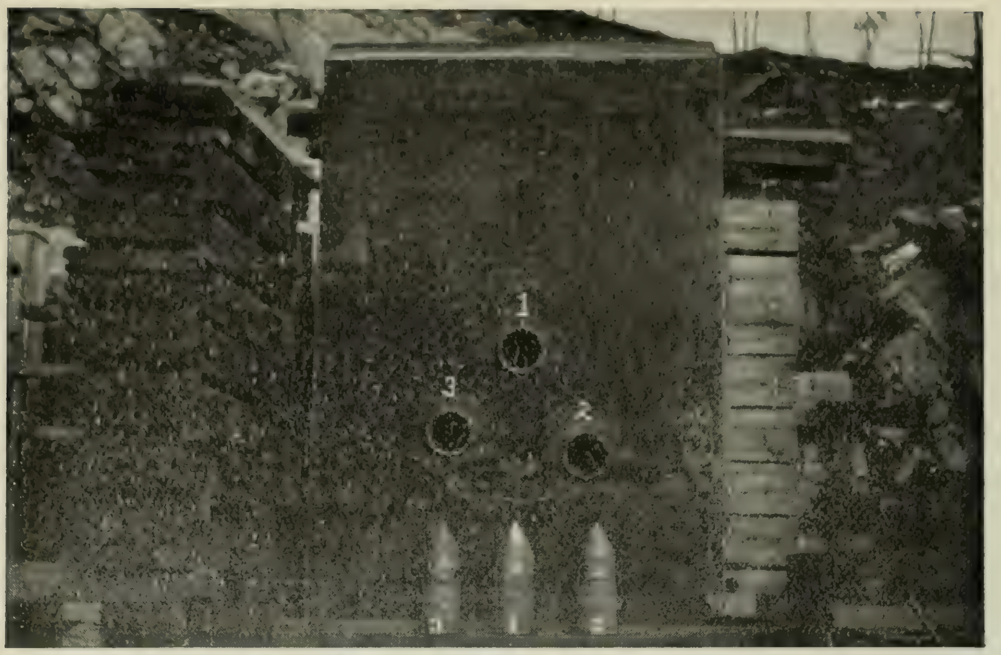


F. Bethlehem 17-in. N-Steel Carbonized, "Indiana's" Barbettes.

tained with nickel-steel armor. In testing the latter, it was presented for a premium, but the premium shot with a striking velocity of 2004 foot-seconds ploughed its way through the plate and backing. Other tests of nickel-steel armor of both of the companies making armor in the United States have demonstrated the admirably uniform qualities that can be obtained. Figure *E* represents a Carnegie 9 inch ballistic plate for the *Monadnock's* side armor; figure *F* a Bethlehem 17-inch ballistic plate for the *Indiana's* barbette. The trial of Bethlehem's



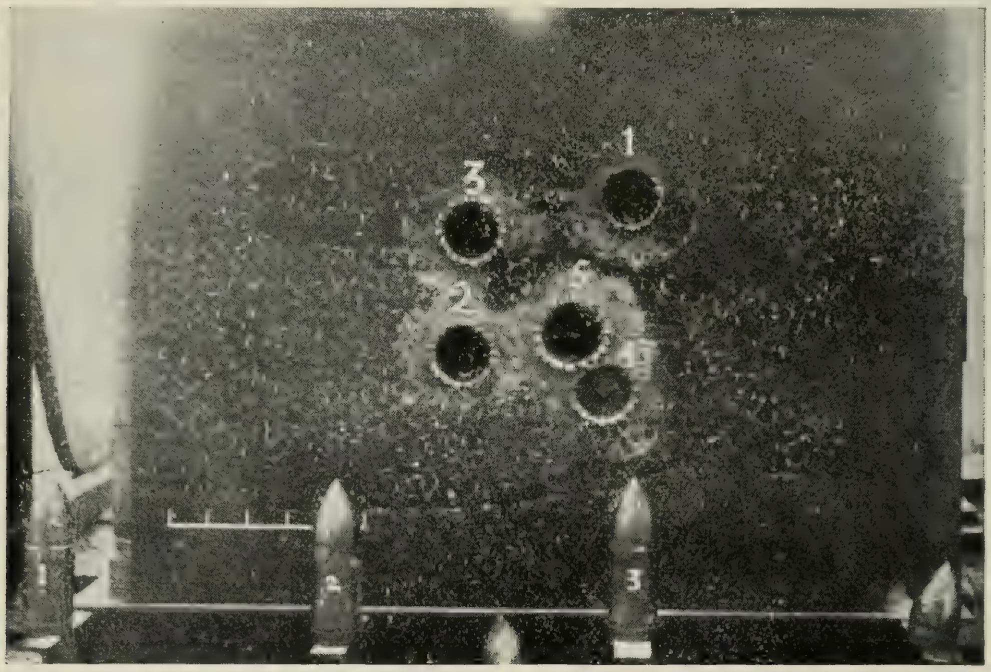
G. Bethlehem 12-in. N-Steel, "Texas" Redoubt.



H. Bethlehem 10-in. N-Steel, "Maine's" Barbette.

second 17-inch ballistic plate representing the *Indiana's* barbette armor showed the same general results as the first except that, as it cracked on the second shot, no premium shot was fired.

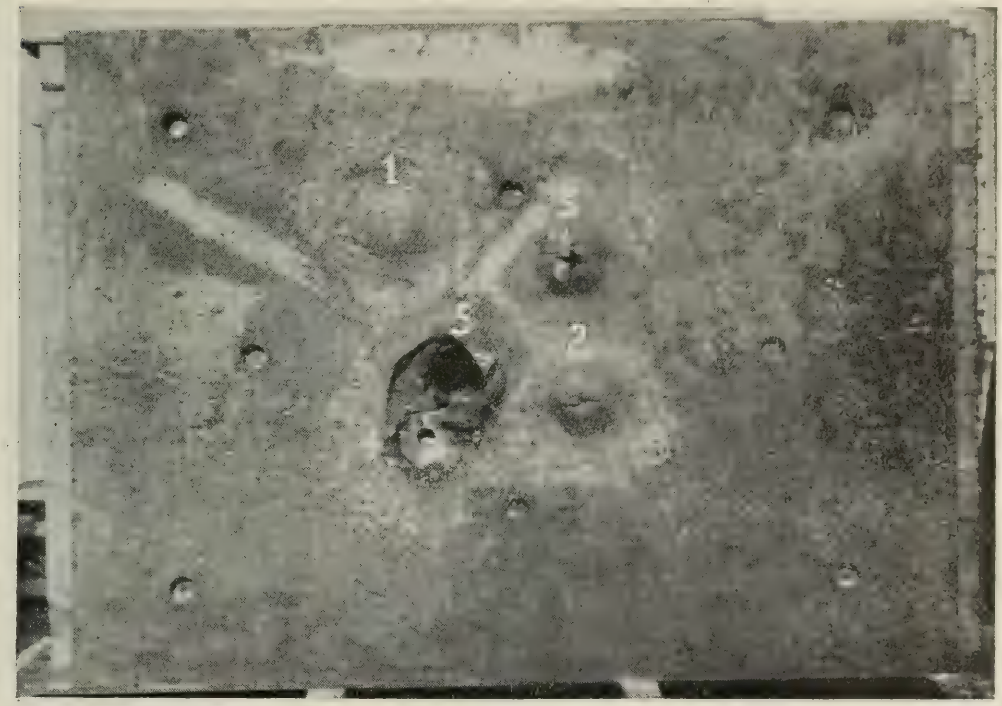
One of the characteristics to be most sought for is uniformity, and this appears to be best obtained in the nickel-steel plates. The cuts,



I. St. Chamond $5\frac{9}{16}$-in. Nickel-Chrome Steel, Front.

G and *H* showing the test-plates of the 12-inch redoubt armor for the battleship *Texas*, and the 10-inch barbettes for the *Maine* are excellent illustrations of this. Even if it cannot be obtained except at a reduction of resisting power, if this reduction is but slight, the certainty of having armor of uniform quality is an advantage. Perhaps this was why the Dutch authorities preferred the St. Chamond plate at the *Texel* trials of August, 1893.

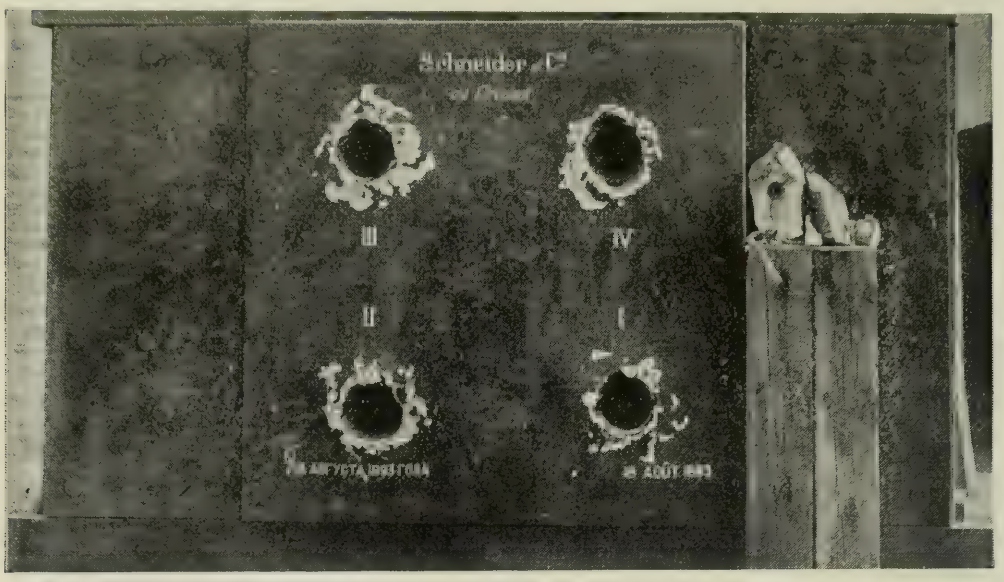
Individual American plates still have the best record unless perhaps we except one of Krupp's, and *that* was nickel-steel supercarbonized by a process of his own. Also the best and thickest carbonized service plates ever made were made in the United States and are of nickel-steel.



J. St. Chamond $5\frac{9}{10}$-in. Nickel-Chrome Steel, Back.

The *Texel* trials of August 23d and 24th, 1893, were interesting, although the dimensions of the plates were small. Brown, Cammell, Krupp, Schneider, St. Chamond and Vickers submitted plates for this trial. All were carbonized except St. Chamond's, which was nickel-chrome steel. Although the Vickers plate proved the most resisting, it was badly cracked, and the Dutch authorities preferred the St. Chamond plate *I* and *J*. I do not know that the Dutch have given to the public a reason for this decision, but a want of uniformity in the results obtained with the surface-hardened plates, their distortion in treatment and the apparent brittleness of the Vickers' sample no doubt had much to do with the decision. Perhaps if Vickers had introduced the right proportion of nickel in the composition of his plate and the plate had been properly worked and treated he would have won on resistance and not lost on brittleness.

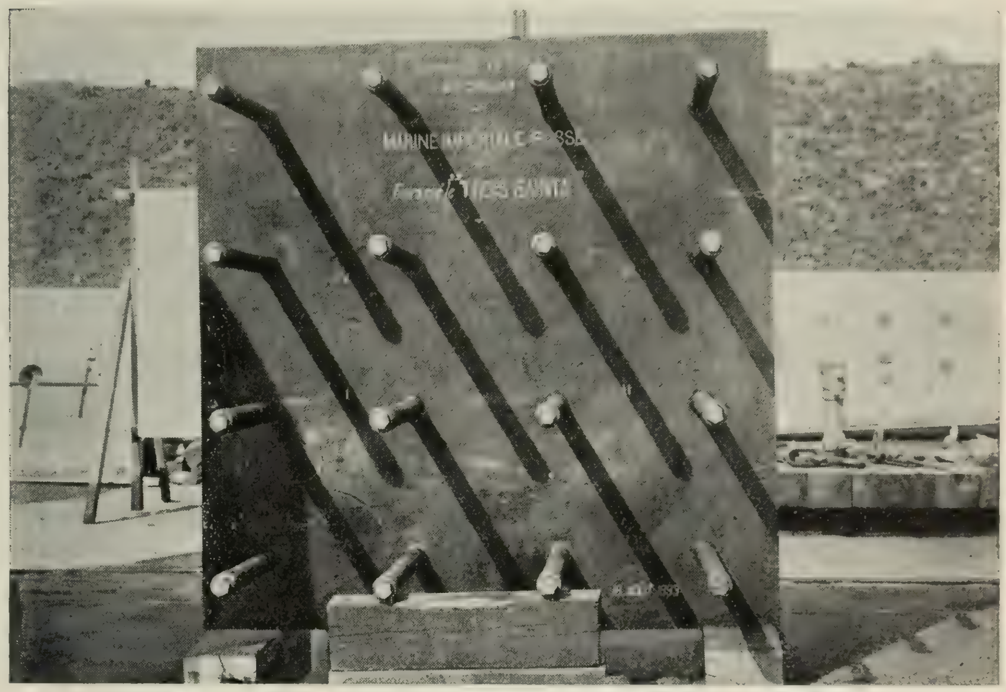
The benefit of carbonization has been abundantly proved, but the limit of the dimensions of the plates to which it can be advantageously applied has not been determined. Not only is the thickness of the hardened surface less in proportion to the thickness of the plate, but the larger masses of steel, when subjected to the sudden shocks of water hardening, are more liable to initiate defects or develop minor ones that may occur in the ingot, which, in the condition they exist after forging, might not sensibly decrease the ballistic resistance. Further, any minor defect that may occur before carbonization is liable to be developed into an injurious one during the very long period the plates are undergoing the process of carbonization. The difficulties of securing uniform results by the Harvey process in thick plates appear to be greater than getting a uniform distribution of the nickel and chrome in the St. Chamond type.



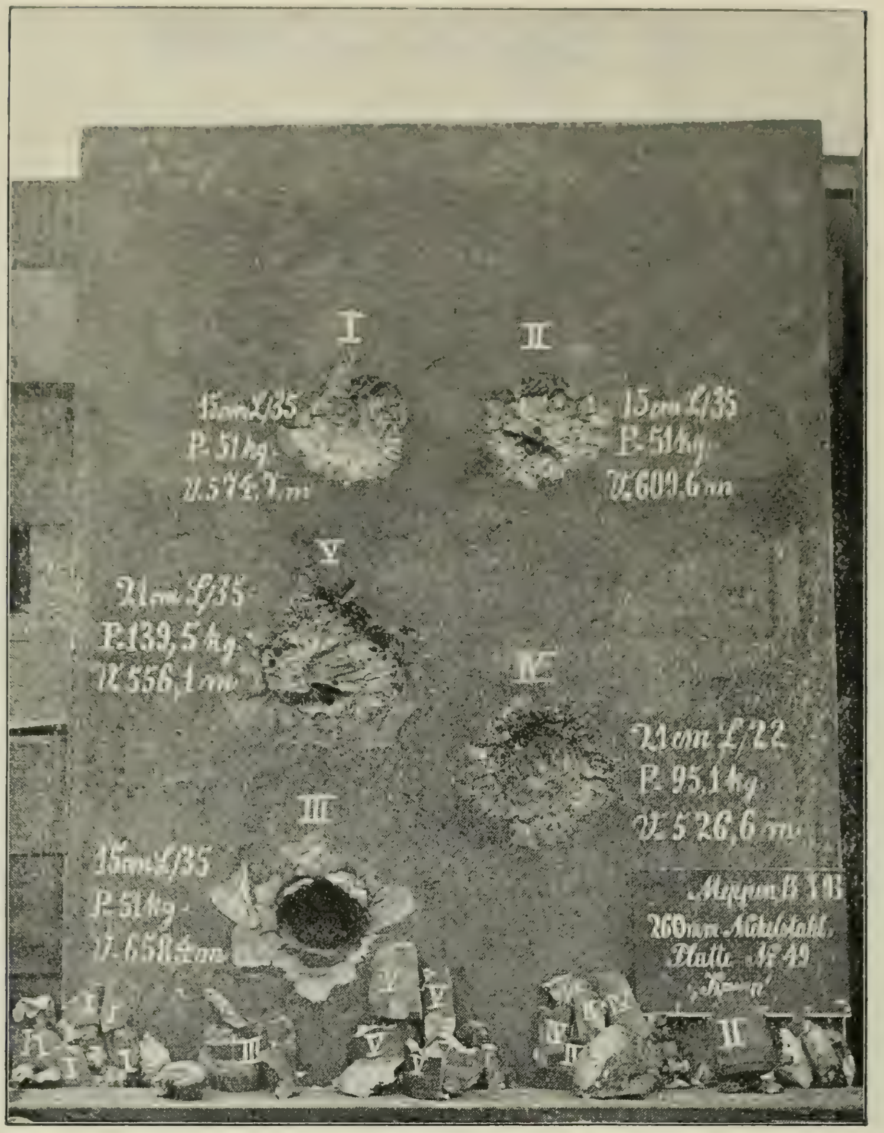
K. Schneider 16-in. Plain Steel Gas Face-Hardened, Side Armor of "Three Saints," Front.

We will not enter here a discussion of the merits of those who have succeeded in getting their names attached to the various patented methods of surface-hardening, but hope that those who deserve it will get the pecuniary benefit. Ellis treated the first thick plate many years ago; Harvey revived this method and with the assistance of the Navy department secured patents which received attention from abroad because of the prominence our Navy department gave them. Krupp's method has not, to my knowledge, been publicly described, but the results he has obtained have equalled the best obtained elsewhere. Creusot, by the patent granted Mr. Schneider, has secured a process by which many of her successful plates have been made, while St. Chamond continues to get most excellent results with her nickel-chrome plates without running risks that the carbonization processes entail.

By far the most important tests of the year were those of the heavy carbonized nickel-steel plates for the battle-ships. Nothing was known from actual tests how these plates would act under the terrible shattering effects of the 12-inch and 13-inch masses of forged steel that have been so successfully made in the last year by the domestic as well as foreign projectile makers. The Harvey treatment for hardening their faces is so unnatural and cruel to the metal that it is not surprising that the steel resents it by setting up strains of such uncertainty that no one can tell what the plate will do when attacked at very high energies. The complicated shapes of the plates themselves add much to the difficulties of manufacture and treatment. While there are other methods of hardening armor which are probably better than the so-called Harvey process, the tests this year have by no means decided the question as to whether a slightly thicker nickel-steel plate does not present a more uniform resistance to the heavier caliber projectiles than the reduced carbonized plate. The great gain in weight however is one that cannot be fully estimated except by those who are required to find stowage



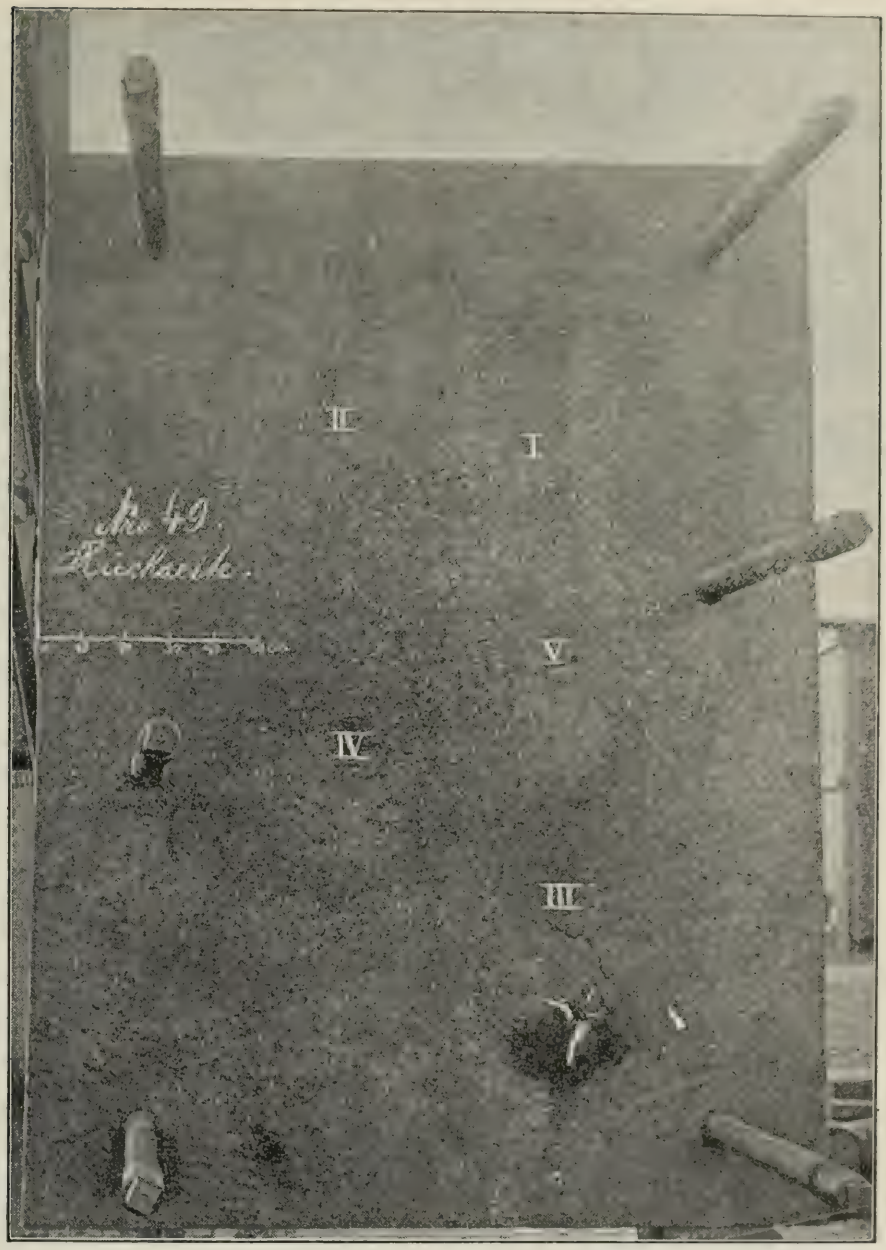
L. Schneider 16-in. Plain Steel Gas Face-Hardened, Side Armor of "Three Saints," Back.



M. Krupp's 10¼-in. Nickel-Steel Carbonized Experimental, Front.

room for more coal, ammunition, provisions, etc., etc., than a ship can ever be expected to carry.

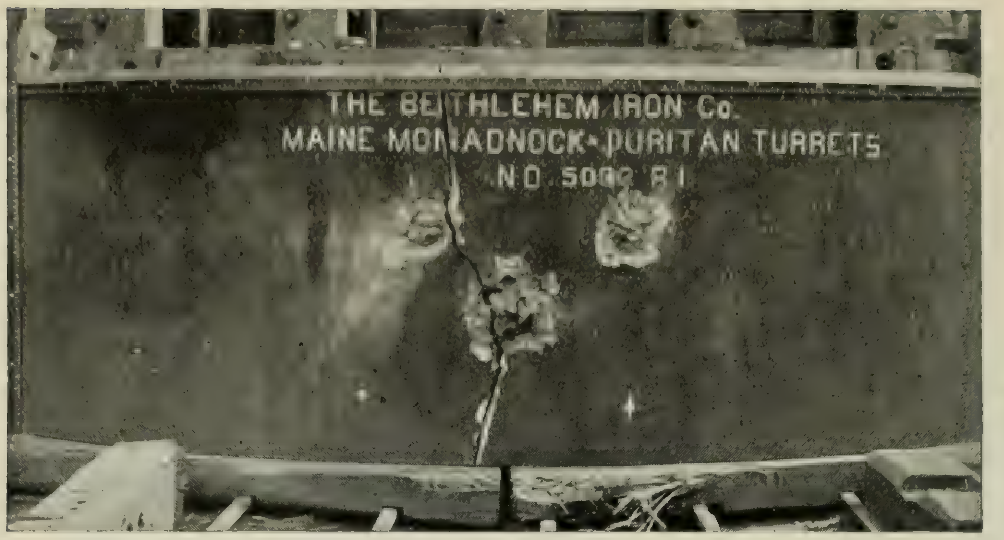
The figures *K* and *L* showing the front and back of the ballistic plate representing armor for the Russian battle-ship *Three Saints* and an experimental plate from Essen *M* and *N* give an excellent idea of what splendid results Schneider and Krupp are securing by their respective methods of carbonization. Schneider's plate had no nickel in it, but Krupp's was of nickel-steel face-hardened by a process of his own. The Schneider plate was 8 feet square and 15.92 inches thick and weighed 18.6 tons. It was attacked by four 9.4 inch Holtzer 318 pound projectiles with the following velocities :



N. Krupp's 10¼-in. Nickel-Steel Carbonized Experimental, Back.

1st	shot	2001	foot-seconds.
2d	"	1949	"
3d	"	1923	"
4th	"	1952	"

All the projectiles were kept out and the back was in excellent condition. There were no important cracks although the plate had received an aggregate energy of 33,753 foot-tons or 1814 foot-tons per ton of plate. Krupp's plate was described in the table on page 414 and shown

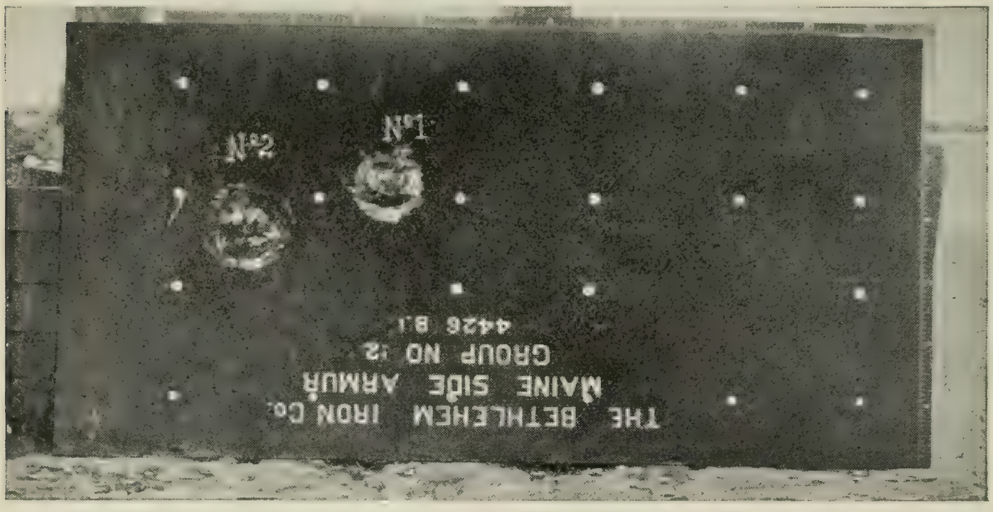


O. Bethlehem 8-in. N. Steel Carbonized, "Maine," etc., Turrets.

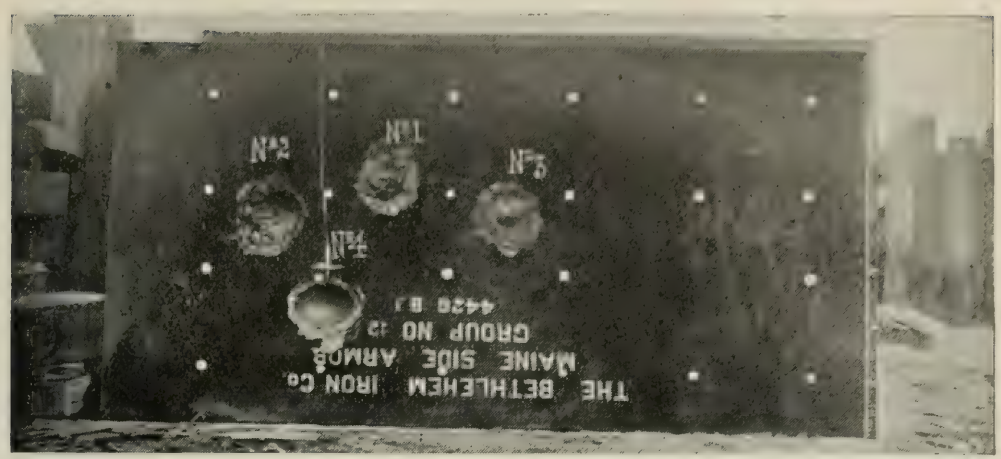
in *M* and *N*. Another excellent example of carbonized armor, until the cracking limit is reached, was an 8-inch plate *O* tested at Redington May 15th of this year.

It represented a lot of turret armor for the *Maine*, *Monadnock* and *Puritan*. The six-inch projectiles were completely destroyed without having any material effect, but when the plate was attacked with 8-inch service energies it was cracked in two pieces.

A Bethlehem carbonized plate, *P*, *Q* and *R* representing side armor of the barbette cruiser *Maine*, was tested at the naval proving grounds, Indian Head, October 14th of last year, and proved to be a very remarkable plate. It was tapered, of 12 inch maximum thickness, slightly curved both horizontally and vertically.



P. Bethlehem 12-in. N-Steel Carbonized, "Maine's" Side Armor After Acceptance Test.



Q. Same as P, After Two Additional 8-in. Projectile Tests.

Two shots were fired at it for acceptance.

First shot: Holtzer 8-inch was broken into small pieces, striking velocity, 1678 foot-seconds; energy, 4885 foot-tons; no cracks.

Second shot: Carpenter 8-inch was broken into small pieces; velocity 2004 foot-seconds; energy 6968 foot-tons; no cracks.

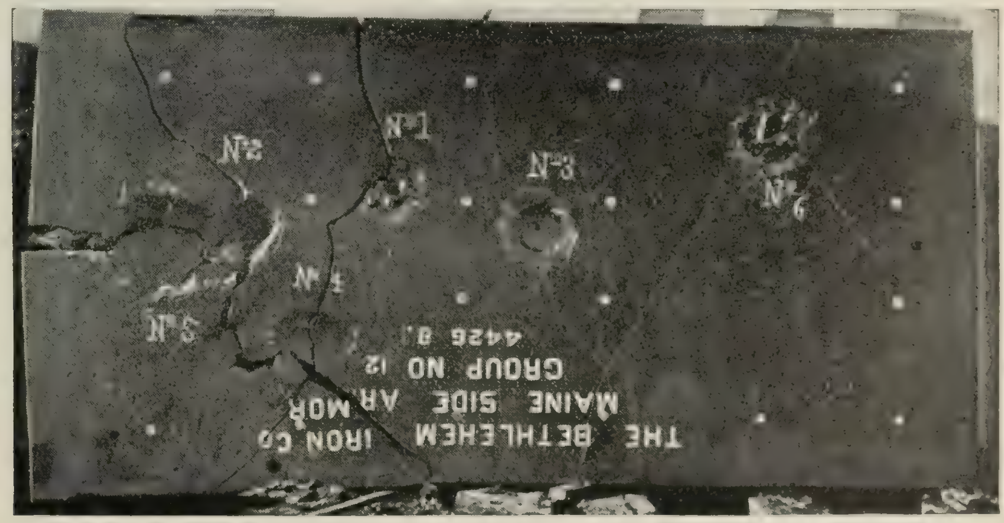
The plate having passed this test admirably, it was used for the following projectile tests:

Third shot: Wheeler-Sterling 8-inch experimental blunt; broke up into small pieces; no cracks. Velocity 2004 foot-seconds; energy 6968 foot tons.

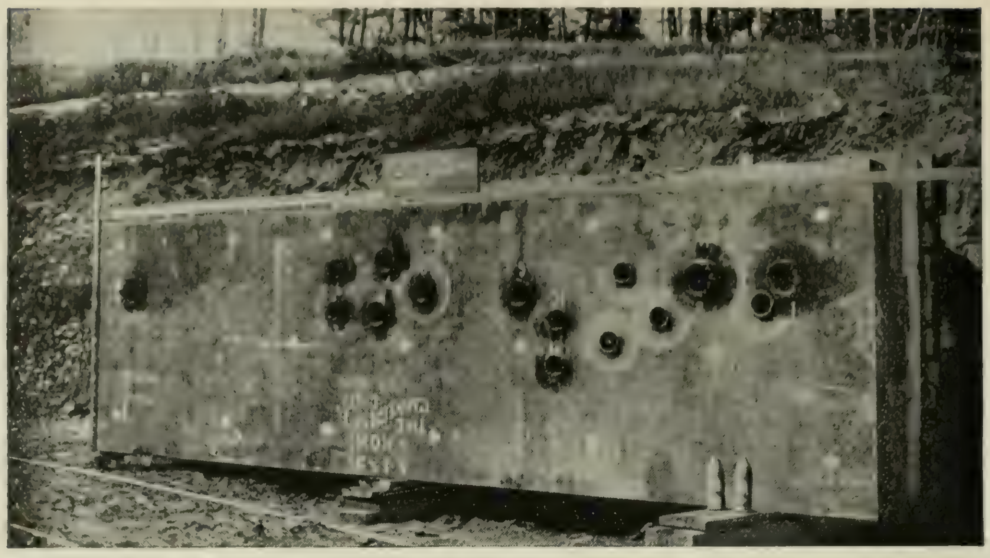
Fourth shot: Carpenter 8-inch; angular impact; broke up entirely; no cracks; velocity 2004 foot-seconds; energy 6968 foot-tons.

Fifth shot: Carpenter 10-inch angular impact; broke up, cracking plate; velocity 1977 foot-seconds; energy 13564 foot-tons.

Sixth shot: Carpenter 10-inch; normal; broke up; estimated penetration about 9 inches; velocity 1691 foot-seconds; energy 9806 foot-tons; plate again cracked.



R. Same as Q, After Two Additional 10-in. Projectile Tests.



S. Carnegie 7-in. N-Steel, Rejected on Account of Laminations.

This plate, weighing about 24 tons, was subjected to a total energy of 49159 foot-tons or 2048 per ton of plate.

It could not be perforated, but was smashed and racked by the heavier projectiles, a marked example of their value.

October 6th a similar plate representing the side armor of the *Texas* was tested at Bethlehem's proving ground. Two 8-inch Holtzer projectiles fired at 1678 and 2004 foot-seconds velocities were broken up. No 10-inch shot was fired at this plate, therefore its power to resist cracking was not demonstrated.

An examination of all these plates will discover that while they destroy the smaller projectiles they are easily cracked by the heavier ones. The type of armor desired must therefore be decided from the point of view of which is the least objectionable, *considerable penetration or cracks.*

The unfortunate complications between labor, manufacturer and officials in connection with the supply of armor by the Carnegie Company has not materially interfered with the supply for our ships. Great Britain's readers are too far away to understand the peculiar conditions, political and personal of this question. Without criticising the methods of the manufacturer or questioning the judgment of the officials, both of them, as well as the American people generally have the gratification of knowing that, as far as investigation and supplementary tests go, the United States ships are protected with better armor than the specifications called for and that these requirements are more severe than those of any other nation.

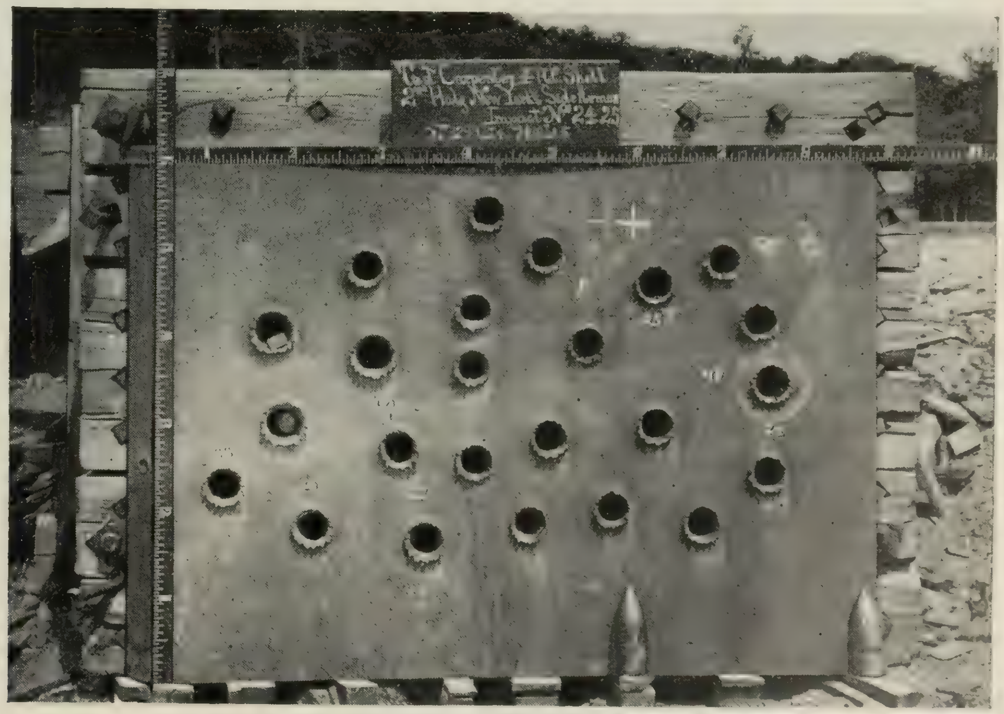
These specifications are too elaborate ; the simpler they are framed the more valuable they will be, particularly if inspectors are to have no latitude in the exercise of their duties and the system of rotation is continued. It is not at all surprising that the present system of inspection should cause friction and a desire on the part of the managers of the contracting works and practical men to follow their own methods of securing the best results.

In relation to the method of testing armor in the United States Great Britain's standard authority, Captain Orde Browne, in the *Engineer*, has said:

"In testing samples systematically for acceptance of the supply of 18-inch plates, the United States authorities are doing what has not been done in this country [Great Britain]. They have instituted a system of inspection and tests of armor which aims at a completeness and at a standard not attempted elsewhere."

This standard has not been fully met here because it was a theoretical one laid down by the authorities before any practical tests had been made of the sizes of plates that it was intended to govern. The makers, ignoring counsel to the contrary, bravely accepted the requirements and delivered some splendid products, undoubtedly the best ever made, but at the cost of some expensive failures and the discovery of the very narrow factor of safety under which they were working.

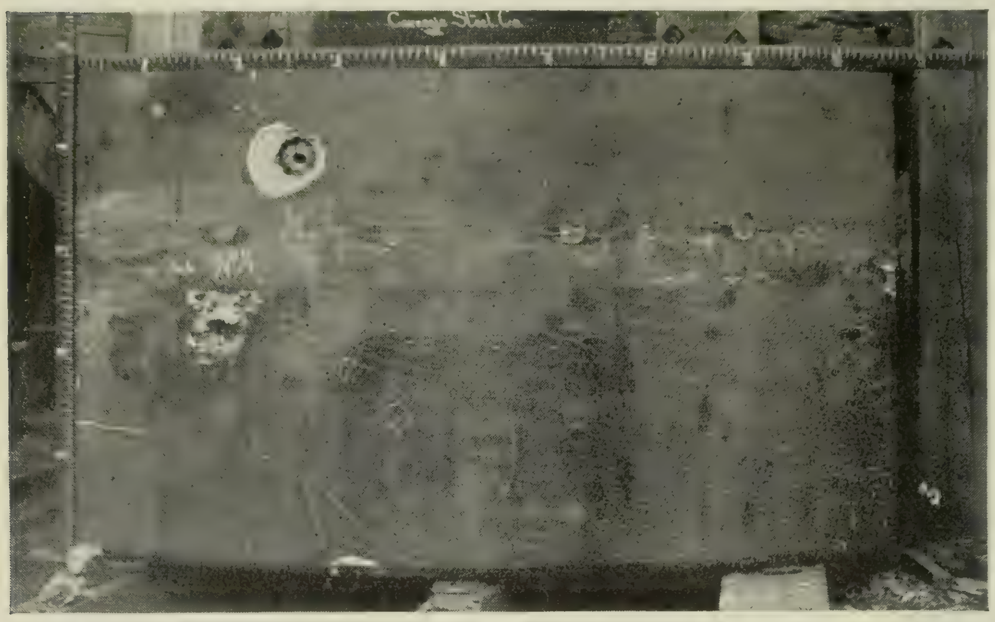
The presence of surface cracks on the hard faces of carbonized armor is not by any means an indication of a lack of resistance. This has been repeatedly shown to be true in both thick and thin plates,



T. Carnegie 4-in. N-Steel, "New York's" Side Armor.

notably in the 6-inch curved Harveyized nickel-steel plates of the Carnegie Company, the 8-inch and 10-inch plates of Bethlehem and a number of thicker plates of both makers. Carnegie's 6-inch curved Harveyized nickel-steel plate A 883,* which was rejected on account of surface cracks, kept out and destroyed two 6-inch Carpenter armor-piercing shells when fired against it with a striking velocity of 1800 foot seconds, the second shot being fired at the cracked portion. The *Terror's* plate *A* 489 *S*, manufactured by the Carnegie Company, has been shot at fourteen times, and although it was rejected on account of laminations, no cracks developed while undergoing ballistic test.

The bottom half of a plate *T* representing the *New York's* side armor, shows the result of twenty-four shots, no cracks appearing anywhere.



U. Carnegie 4-in. Curved N-Steel Carbonized.

Our Navy department, however, not being fully convinced how much latitude can be given the makers in this item of surface cracks, and how much they may affect the ballistic resistance of the plate, gave particular attention to this point in the test of a 4-inch curved nickel-steel carbonized plate *U* from the Carnegie Company. Like its surface-cracked predecessors it passed the required test satisfactorily.

A careful inspection of the methods and alloys employed in the manufacture of armor in the different countries discovers results which are difficult to accept. Great Britain has decided that the additional cost of the employment of nickel is not justified by the results; that its use causes characteristics which are injurious; but she has made no comparative tests of thick plain steel and nickel-steel, such as have specially proved in America the value of nickel in armor-steel. The inferior results that have been obtained in the United States when chrome- and nickel-chrome plates have been experimented with are also surprising. When we consider the very excellent results that Witkowitz and St. Chamond have obtained and the large quantity of excellent armor the latter has turned out where her nickel-chrome, untreated, uncarbonized armor has equalled, and in some cases surpassed, Harveyized plates, it would seem to be to the want of experience in the composition or subsequent treatment that failures must be ascribed.

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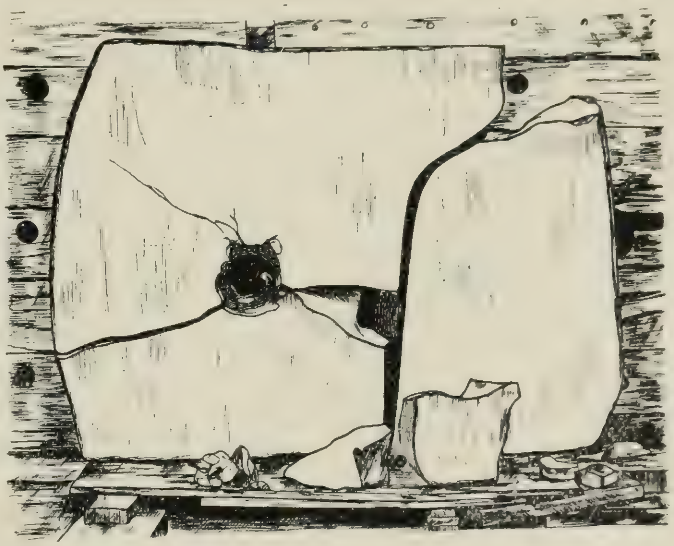
* The *Army and Navy Journal,* in its issue of June 23, 1894, has given an illustrated description of the test of this plate.

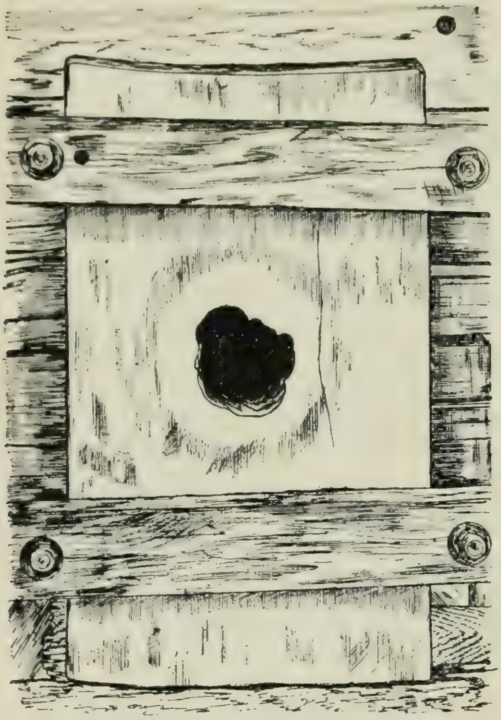
The experimental nickel-chrome steel plate, Figure *V*, was manufactured by the Bethlehem Company. Its complete demolition by one 8-inch projectile would seem to indicate that something was radically wrong in its manufacture since nickel-chrome plates of approximately the same composition have not only shown most excellent results, but in two cases have beaten their competitors. I have advocated nickel-chrome armor because of the possibility of securing a very satisfactory product without the risks that Harveyizing entail in all plates, particularly in the thicker ones.



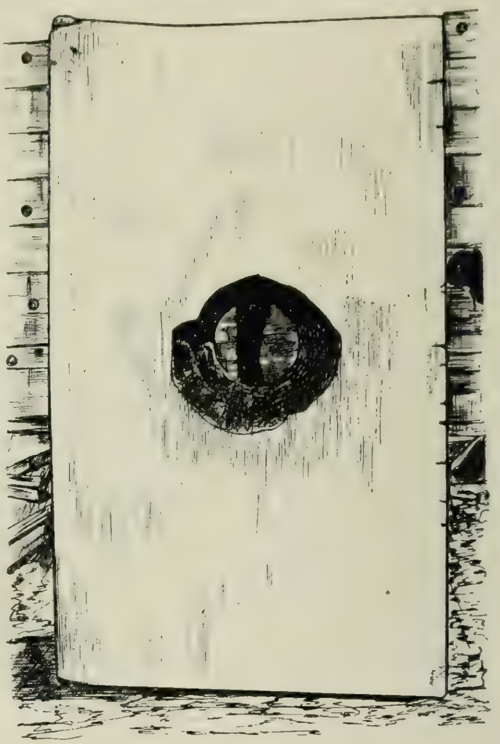
V. Bethlehem 9-in. Nickel-Chrome Steel, Experimental.

The test of thin shield plates containing alloys of chrome, nickel, and manganese, carbonized and uncarbonized, have not been productive of important results. They will no doubt be continued by the makers as well as by the Army and Navy departments, since such experimentation can be carried on at a moderate cost. A very tenacious, resisting nickel-chrome plate ought to be obtained without much difficulty, but considering the comparative ease with which thin plates can be surface-hardened, the nickel-steel carbonized plate ought to be as good as any. We have had so many tests of thin plates that we can prepare curves of resistance for them that can be almost perfectly relied upon. Specified qualities in these thin plates ought to be as readily obtained as standard boilers or shafting.

In connection with thin plates mention must be made of the successful practice that is being obtained with our 12-inch rifled mortars. Uncarbonized alloyed metal will probably resist mortar fire as well if not better than any other type, as brittleness must be avoided as much as possible where low velocity large caliber projectiles form the attack. All of the plates thus far tried have cracked badly. Ships not especially built with armored deck protection, must regard effective mortar fire with grave apprehension. With mortar fire from above and submarine artillery from below the bravest commander will hesitate to attack a thus protected port.



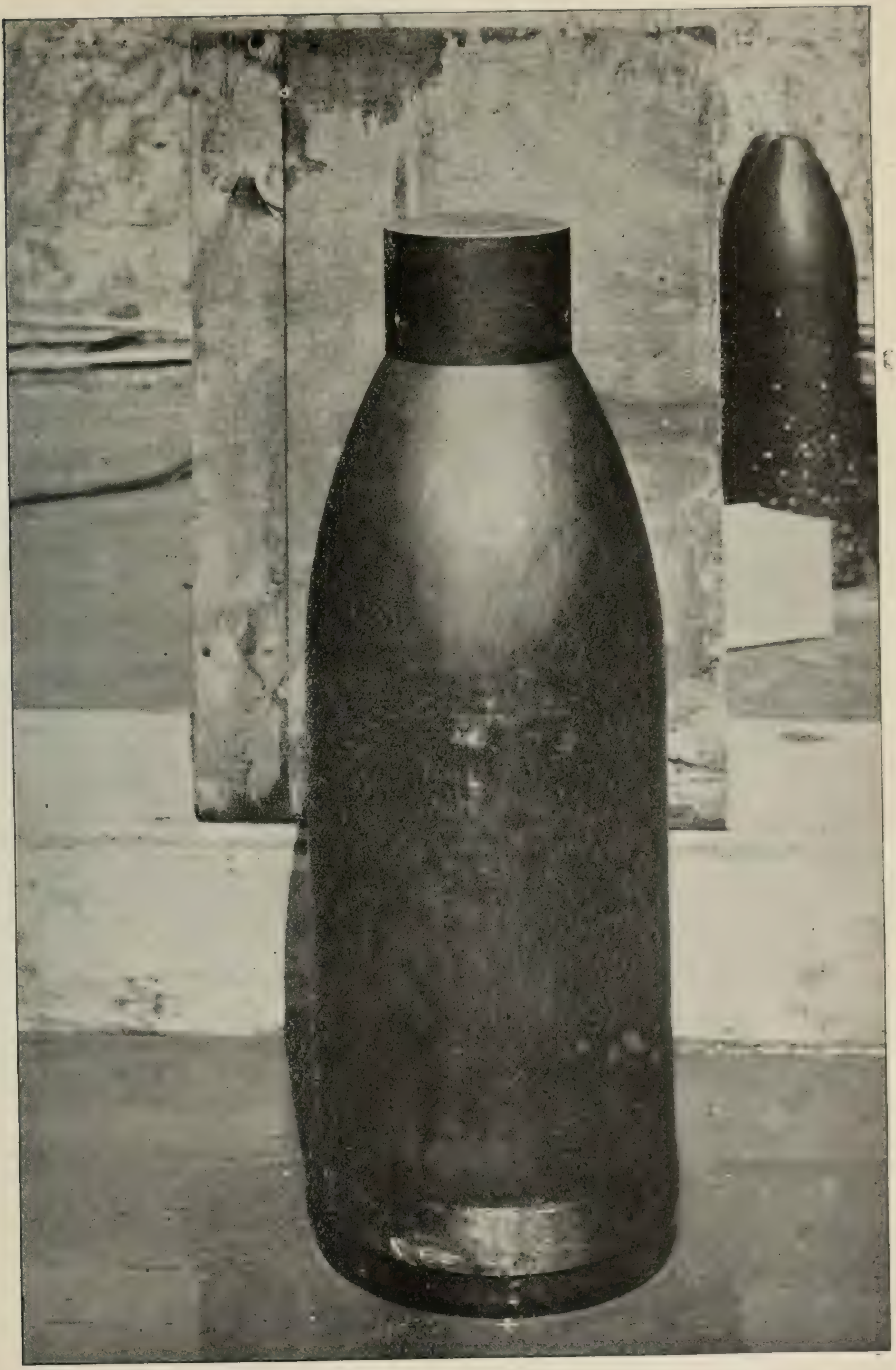
W. Hadfield 5-in. Manganese Steel, Experimental, Front.



X. Same as W. Back.

In March last a slab of Hadfield manganese steel was forged into a 5-inch plate and hardened by the Bethlehem Iron Company. It was attacked with a 6-inch Holtzer armor-piercing shell at 1400 foot-seconds striking velocity. Greatly overmatched, it was completely perforated, *W* and *X*, but there were no cracks nor fringe, nor bulge. While the plate did not exhibit the resistance expected, the test furnished another demonstration of the value of manganese as a toughening agent.

Unlimited discussion continues as to the comparative value of



Z. Johnson 10-in. Cast Steel Shot with the Soft Steel Cap on.

actual remaining velocities by the use of screens behind plates in testing armor and projectiles. A large number of the latter perforate the plates and much valuable data could be obtained by their use to replace assumed arbitrary conditions and to lessen the demand upon the Greek alphabet which is so copiously drawn upon to represent the unknown quantities of ballistic equations. Not only is this true in determining the comparative resistance of plates but equally so in grading projectiles, which, in many cases, fired with high velocities, are either lost or not discovered until one of the approximate elements of value—heat – has disappeared.

The results obtained in the United States can safely be taken as a standard of what protection can be obtained with various thicknesses of armor, because more serious and numerous tests have been made with each than is the custom in other countries, notably Great Britain. Although England occasionally tests a plate of service thickness her general practice of reducing plates to a thickness of six inches for ballistic acceptance, while supplying a uniform specimen for test and comparison does not give results that will always hold true in plates of greater thickness, or be a guide for the valuation of the service plates themselves.

Lieutenant Weaver's very thorough "Notes on Armor," published in the "Journal of the U. S. Artillery," and Captain Orde Browne's articles in the London *Engineer*, and Brassey's "Annual," have followed the armor question with much care. Very many more details will be found in their series than can be brought together in this short article.

The tests of the past year have enabled us to reach conclusions that will enable our Navy department to contract for armor for its variety of purposes that will insure our getting the best, and we have again proved to our legislators that all we need is adequate financial encouragement to enable us to lead in all branches of naval architecture and ordnance engineering.

NOTE.—The writer thanks the Chief of Bureau of Ordnance, the Commanding Officer of the Naval Proving Ground, the Naval Institute, the manufacturers and others for their assistance in the preparation of the illustrations.

ECONOMY IN MACHINE SHOP MANAGEMENT.

By James Brady.

WHERE should workshop economies begin? Where should they end? The latter question is much the more easy to answer. Shop economies should never cease. To maintain them, however, in all departments, will require unremitting vigilance.

Most men in assuming the superintendence of a workshop look first into the boiler- and engine-rooms to see what is going on there. This seems to indicate a prevailing belief that these parts of a factory or machine-shop plant are those in which wastes are generally most likely to be discovered.

Indicator diagrams will probably be taken; boiler examined for scale; quality of the fuel inspected, and the manner of firing scrutinized. This is all commendable if the search for wastes does not substantially end here, as it does too often.

A superintendent, assuming a new position may reasonably expect to find more or less waste going on throughout the entire establishment of which he assumes the charge. If there had been no reason for a change as regards his predecessor, the change would not have been made. The exceptions to this would be where a vacancy has occurred through the death of the previous incumbent, or where he had resigned, having been called to a more advantageous position by reason of his known efficiency, and induced to make the change by the offer of a higher salary. And even in the case of such exceptions the new superintendent may be able to detect lapses in economies, that escaped the other, since "two heads are better than one," and he will probably look from new points of view upon what is going on.

Opportunities for economy should, therefore, be sought everywhere. Economies in the counting-room, workshop, packing-room; economies in purchases and sales; special economies that may be effected in the performance of special jobs. In short, the study of economy is the study of how to achieve success in any kind of manufacturing industry, big, or little. And unless economy includes small things it will never comprehend the large; all that is large depends upon small things.

Economy is a matter of habit, like good language, or good manners. It must be a matter of common usage or it will fail when most needed. This study should be pursued with ardor morning, noon and night. It should pervade the atmosphere of the shop, so that each man and boy shall breathe it in, and become imbued with its wholesome spirit. "A penny saved is two pence earned." "Waste not, want not." The full meaning and import of these maxims should be absorbed by every one who does anything in a shop, from the proprietor and superintendent down to the man who sweeps up the floors, and the watchman who cares for the place nights and Sundays. And if it is not in a superintendent to inspire a wholesome degree of this spirit in the workmen under his supervision, he may be a skillful mechanic enough—a good engineer—a bright, intelligent man, but he lacks one of the most important qualifications of a superintendent.

Let it be understood at the outset that economy means the avoidance of needless wastes, not niggardness, which latter Sir Philip Sidney called a "sluttish vice." Economy is a virtue, not a vice. Economy is honorable, and has been so ever since Solomon wrote the Proverbs. "There is treasure to be desired and oil in the dwelling of the wise; but a foolish man spendeth it up." To be niggardly and parsimonious is to be mean—despicable. Niggards generally fail in true economy even when they attempt to practice it. To save the immediate penny they hazard the future pound. I advocate no such economy as this; nothing that is inconsistent with just and reasonable liberality. The economy I am speaking of is reasonable—even generous; he who is not economical can rarely afford to be generous.

It is my purpose to write more particularly of special economies in the performance of special work. My experience has compelled my attention to such economies more than usually falls to the lot of mechanical manufacturers. The kind of work with which I have occupied myself for many years is the building of new experimental machines; and thereafter, if these continue to be made to simplify and cheapen their production and manufacture them on contract.

In the construction of new machines there are usually few precedents upon which to base estimates. He who undertakes to build them at a previously estimated cost, will often be required to exercise his ingenuity to the utmost in order to effect such economy of time, tools, and material as will leave him a reasonable margin of profit. Many times I have saved myself serious losses by the adoption of entirely original methods that largely reduced cost of manufacture, and some of these will be illustrated and described, in the hope that they may afford useful hints to others. But before entering upon this part of the subject there are some general economies to be noted.

Economy of temper and worry is a most important thing to be sought by any man who conducts a manufacturing business. Of what good is a competence, or even wealth to a man with shattered nerves and ruined digestion? If a man cannot govern his temper, in a business wherein exasperating mistakes are to be expected, if he allows himself to continually worry over temporary failures and disappointments, he may perhaps amass money, but the care-furrows will be plowed too deep in his forehead to enable him to enjoy the fruits of his industry. Self-control is therefore one of the first economies to be learned in business. It saves health, happiness, and even life. Temper and worry have carried many a man to an untimely grave.

One of the means most effective in preventing worry is an easy, intelligible, exact, handy and economical system of accounting; and I early turned my attention to organizing a system that should comprise all these features. Though usually in prosperous times having a great variety of work in hand, I find the services of a single bookkeeper all that is required to keep an accurate record of all work in every one of its stages from commencement to finish, together with all general accounts needed to give a complete history of the business.

In the morning as the men file in to their work past the counting room, each is given a card or ticket. At the head of this ticket is printed one of the conditions of their employment, to the effect that all employés must assume and bear all responsibility of personal injury received while in the employ of the concern. There are also printed at the top of the ticket the statement that "all help is employed by the hour," and the injunction to enter at the end of work on any particular order in columns ruled and headed for such entries on the ticket "time and stock on the same before starting on new work." There is also a place for writing the date. On the left margin of the ticket is printed the direction never to use machines or tools that are out of repair, and in this injunction is implied one of the fundamental economies in shop practice. I need not further enlarge upon this point. On the right margin of the ticket is printed the caution "Carelessness around machinery is dangerous." Below the date line, at the top of the ticket is a line where the workman enters his name and his number, each man having been assigned a special number when engaged. The employment of numbers for men and for orders saves a deal of writing. The ticket is ruled to make four vertical columns for entries. All orders for work, whether job work, contract work, or repair work of tools and shop appliances, are each assigned a special and consecutive number when they are commenced. The first vertical column is headed "*Order No.*"—, the blank being for the numeral and the column of a width to conveniently receive a number of six figures. The second is headed "*Part No.*," which permits a special record and accounting of parts of orders to be made when this is desired, and this is often desirable in the kind of work done in many establishments. The third column of the ticket is headed "*Character of Work*" and is wide enough to admit the insertion of explanatory words; as for example, "*altering patterns of drop-pawl*;"

and the fourth column is headed "*Hours.*" In this the workman records the number of hours he devotes to any order or part of an order. There are seven horizontal lines on the ticket for writing; this number is found sufficient. A sample entry made by a workman would read as follows:

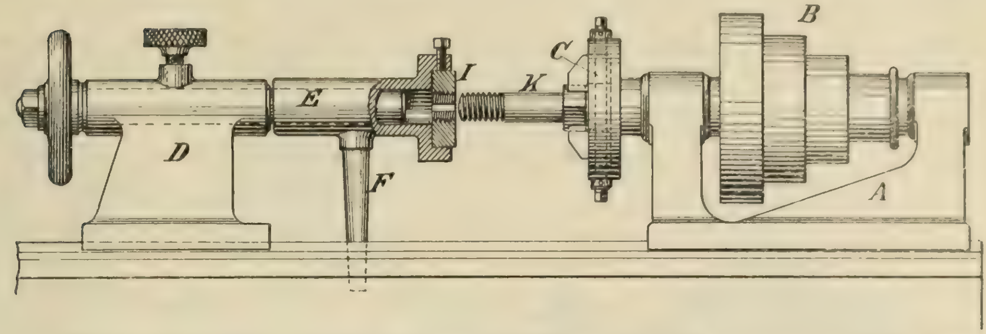
Order No.	Part No.	Character of Work.	Hours.
3451	34	Altering Drop-Slide.	8½
"	"	Stock, 3 lbs. Cold Rolled Mach.	
"	"	Steel.	

At the bottom of the ticket is printed in bold red letters the direction "*Don't fail to charge stock.*" In a final line are printed the words "*Foreman's Check,*" opposite which, at the close of the day, the foreman, examining the ticket, signifies its correctness. There is also a place for writing the total number of hours worked on the one or more jobs, with which the workman has been employed during the day. On going out at night he drops this ticket into a receptacle

It will be seen that this ticket amounts to an itemized bill rendered by the workman in his own handwriting for each day's service, and places in the bookkeeper's hands all the data necessary for keeping an exact account of any job or any part of it. The work book has columns for collecting under special order numbers the information supplied by the workmen's tickets, relating to each order, and each week a bill is rendered for each order on which work has been done, a press copy of this bill being made in the salesbook. Thenceforward the bookkeeper has to deal only with the footings of these bills, requiring only one ledger entry for total charges on any order for the week. If twenty orders were in hand, there would be twenty of these entries to post, and as the books are kept by the double entry system there would be only forty ledger entries.

On the work book provision is made for a column of totals. Each day's expenditure for labor and stock is added to the previous total, so that at the end of any day, the amount any job has cost up to that date may be at once read off. The same system applies to parts of work when their cost is desired to be ascertained. The bookkeeper first enters from the tickets the total of hours each workman has worked in the time book, which is our pay roll, opposite his number. Then this time is entered against the order numbered in the work book, with the price per hour of the labor, and a simple multiplication gives the extension which is assigned to a special column. Charges for stock are treated similarly. A system of proof sheets checks the whole system for errors, which, however, rarely occur.

FIG. 1.

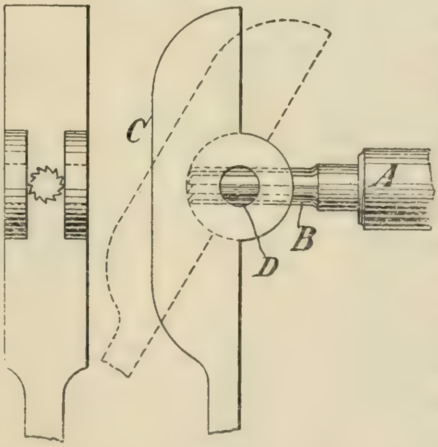


There are other details of convenience in this system, which, however, must give place to some mechanical economies which have helped out greatly in the execution of a variety of work wider perhaps than falls under the experience of most mechanical engineers.

A quick and very effective way of flattening punched blanks of brass or other ductile metal is to bunch them in lots of a dozen or more lying one upon another, and strike the bunch with a drop-hammer. Blanks may be very quickly and perfectly flattened in this way, that could only with great difficulty, if at all, be brought to the same perfection by treating them singly.

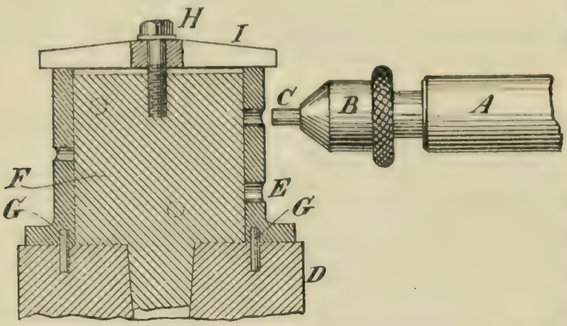
To do bolt cutting on any lathe the arrangement shown in Figure 1 may be employed. *A*, is the head stock; *B*, cone pulleys; *C*, chuck; *D*, tail stock; *E*, a sleeve fitted to slide on and over the tail stock spindle; *F*, an arm attached to the sleeve *E*; *I*, screw cutting die. The blanks *K* for the bolts, having been cut to desired lengths and pointed, are chucked, and being entered at the pointed end into the die the cutting is readily performed, the sleeve *E* being prevented from turning by the arm *F*, but sliding freely on the tail spindle *E*. A method of milling out the inner surfaces of what are known as rule-joints is shown in Figure 2. *A* represents the live spindle of a Brown and Sharpe milling machine. *B* is a cylindrical milling cutter, mounted in the spindle; *C* is the work mounted on the revolving head of the machine, and so adjusted that it makes a partial revolution around the center *D*. These joints which are of frequent occurrence in certain kinds of machine construction can be rapidly, accurately and cheaply fitted by this method.

FIG. 2.



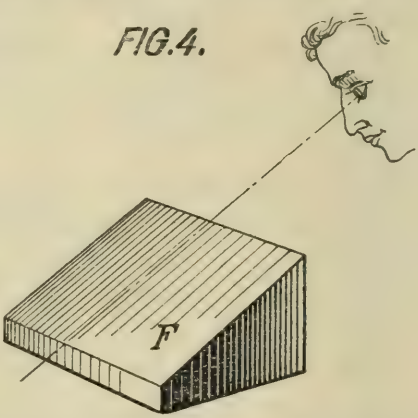
There came into my establishment at one time an order to make ten knitting-machine cylinders. These were hollow, and through their sides there were to be drilled a number of holes disposed in a certain way. A sample cylinder was sent with the order and the order was explicit that the holes (all of one size) must be bored and located in positions exactly the same as the sample. The expense of a jig for this work put this resource out of the question at once. Another method was resorted to which located the holes perfectly.

FIG.3.



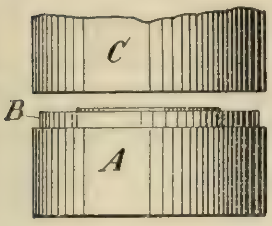
This is illustrated in the sketch, Figure 3, in which *A* represents the spindle of a Brown and Sharpe milling machine; *B*, a drill chuck; *C*, a test plug of the exact size of the holes to be drilled; *D*, the worm head of the machine; *E*, the cylinder to be drilled—shown in section and having holes at the bottom for dowel pins, *G*; *F*, a cast-iron piece made to fit the interior of the cylinders and fastened to the worm head so as to properly center the cylinders; *I*, a clamping bar which firmly held the cylinders when the screw bolt *H* fitted into *F* was tightened down. The adjustment of the pattern cylinder having been exactly made for any one of the holes so that the test plug would exactly enter it, the head was allowed to remain in the same position, the pattern cylinder and the test plug removed, the cylinder replaced by a cylinder to be bored, and the test plug by the drill, and the holes were thus exactly drilled in their required places. The dowel pins at the bottom which were all drilled in the same position relatively to one of the holes, insured the correctness of position of any hole in the horizontal plane. Of course some time was consumed in handling, but the cost of this was only a small fraction of the cost of a jig.

FIG.4.



A handy time-saving device is shown in sketch Figure 4. This is a combined anvil and face-plate having an inclined face *F*. This face is made true and may be called an inclined face-plate. It is used as an anvil in straightening pieces with a hammer and in testing pieces for straightness, and where a considerable number have to be handled, it saves a great deal of time. For example suppose a workman to be holding in one hand a piece

FIG. 5.



which he has been working upon by a tool held in the other hand ; he can, without laying down the tool (file or hammer), apply the piece to the face-plate to discover defects, instead of laying down the tool, taking up a straight edge and adjusting the piece to the straight edge. In work of this kind minutes rapidly multiply into hours, and if seconds can be substituted for minutes, it is worth every man's while to do this.

The diagram, Figure 5, illustrates a method of compressing to gage brass blanks, by hydraulic force. *A* is the anvil ; *B*, a ring gage ; *C*, a follower. The blanks are successively placed in the gage and pressure applied. It is a much cheaper process than turning them off, and it compacts the metal so that the gears are stronger and wear better in use.

FIG. 6.

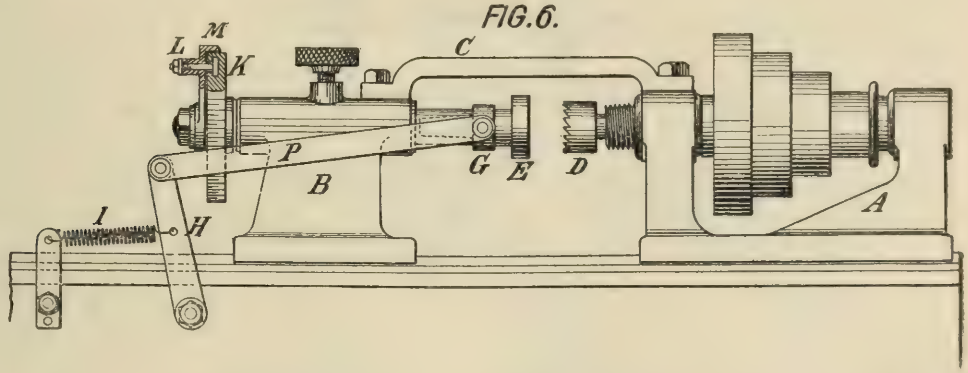


Figure 6, illustrates a method of face-milling to gage, in a lathe. *A* is the headstock ; *B*, the tailstock ; *C*, a stiffening brace bar ; *D*, milling cutter ; *E*, piece operated upon ; *P*, a link pivoted to the collar *G*, and at the other end to a rock bar *H*; *I*, spring ; *K*, graduated hand wheel on tailstock spindle ; *L*, an adjustable stop attached to *K*, having an index finger and so set that when the spindle has advanced to the right point to gage the cutting, the end of the rock bar is brought under it, and the motion of the spindle is thus arrested. Face milling to a uniform gage can be thus performed with dispatch in a common lathe to within $\frac{1}{10,000}$ of an inch.

FIG. 7.

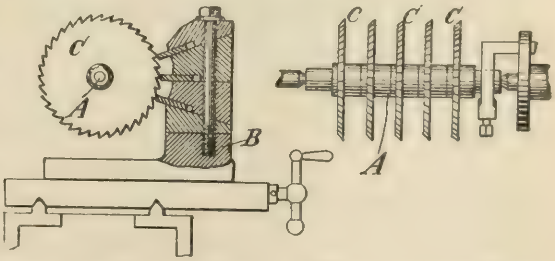


Figure 7 illustrates a method of rapid ratchet or square tooth cutting. The cutters *C* are mounted on an arbor *A* which is held in a lathe and revolves in the usual manner. *B* is a clamping holder mounted on the carriage of the tool post and arranged to hold three pieces to be operated upon at once. I have used ten cutters in this way so that at each feed 30 teeth would be simultaneously cut. The cutters on the arbor are set at a uniform distance apart, which distance is some multiple of the pitch of the teeth to be cut in the rack. The carriage is moved along intermittently after each cut by the lead screw or a special screw worked by hand.

A method recently devised and employed by me in cutting a large number of thin segmental racks, the pitch line of which was required to be on a radius of 36″ is shown in Figure 8. *A* is the dead center and B the live center of a common lathe. On the shears of the lathe are rigidly clamped two strong triangular iron frames, *F* and *G* projecting horizontally forward. To *F* is attached a movable frame *D* by a universal joint at *M*. A similar frame *E* is connected at *N* to *G* in a similar manner. The frames *D* and *E* are connected by a link, *H*, so that one moves precisely like the other, in a horizontal plane, on ways at the front ends of the frames *D* and *E*. On the front end of E is a clamp which holds the blank sector *L* to be cut. On the front end of *D* is a toothed sector in which meshes the worm wheel *I*. *K* is the milling cutter, the teeth of which are arranged in manner analogous to the teeth of a die for tapping nuts. Both *I* and *K*, have a very small pitch and their diameters are large in proportion to their pitch. They are mounted on an arbor *O*, which is supported by the lathe centers and driven in the usual way, *I* acts through the toothed sector and link *H* to feed the blank *L* to the cutter. I should hesitate to say here, how rapidly and cheaply I can cut a thousand of these racks with this device; the figure is so low that it would hardly be credited unless the operation is itself first witnessed. As each rack is completed, a new one is substituted, and by means of a rope running over a pulley and attached to an eye in the middle of the link, the front part of both *D* and *E* are lifted and swung back to their initial position.

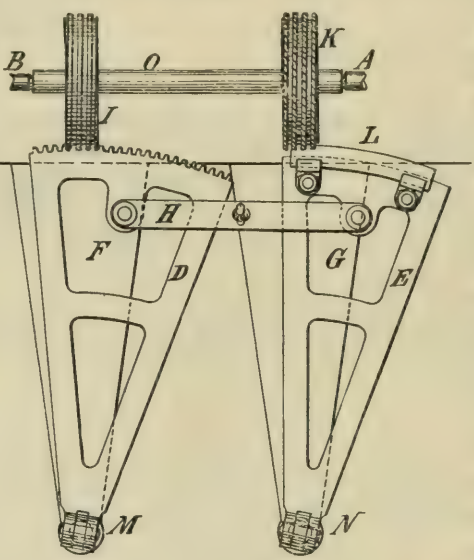


FIG. 8.

In milling male and female dies for rolls intended for use in rolling out tin and brass trays, I arranged to do the work—thought by many good mechanics to be impossible—as follows: On the carriage of an ordinary lathe, Figure 9, the head stock *A* was mounted, and the cone pulley operated by a belt from a countershaft. The live and dead centers of the lathe supported the roll *G*, upon which the dies were to be mounted in use. To this roll was bolted the piece *D*, to be milled. To this again was bolted a ring-gage *E*. On the head-stock spindle was mounted the milling cutter provided with the collar *F*. This collar, bearing against the ring-gage when milling, the cutting was limited to points within the ring-gage, all parts of which being cut away, the die attained the correct shape. The figure shows a female die, but the male die is milled in an entirely similar manner.

In constructing a considerable number of small machines, many pieces of steel cut in rectangular form, had to have two of their sides made parallel, and the pieces were to be brought with exactness to a standard thickness. One side was made true by lapping. How to get the opposite parallel and bring the pieces to the required width rapidly and cheaply was answered by the device shown in Figure 10. Any shaper will do for this work. To the bed is fitted a metal piece *A*, planed out midwise to receive the hard steel guide *C* and the fixed cutter *B*, leaving a flat-bottomed space between *B* and *C*. Extending laterally is a channel *F*, in which the pieces *K* to be shaved off are placed. *F* is a follower, having the stem *G*, and actuated by the springs *H*. *I* represents a pusher fastened in the tool-holder of the shaper, and which is made to traverse through the space between *B* and *C*, pushing before it one of a series of the pieces *K* which are placed in the channel *E* with their lapped sides toward the follower. In pass-

FIG. 9.

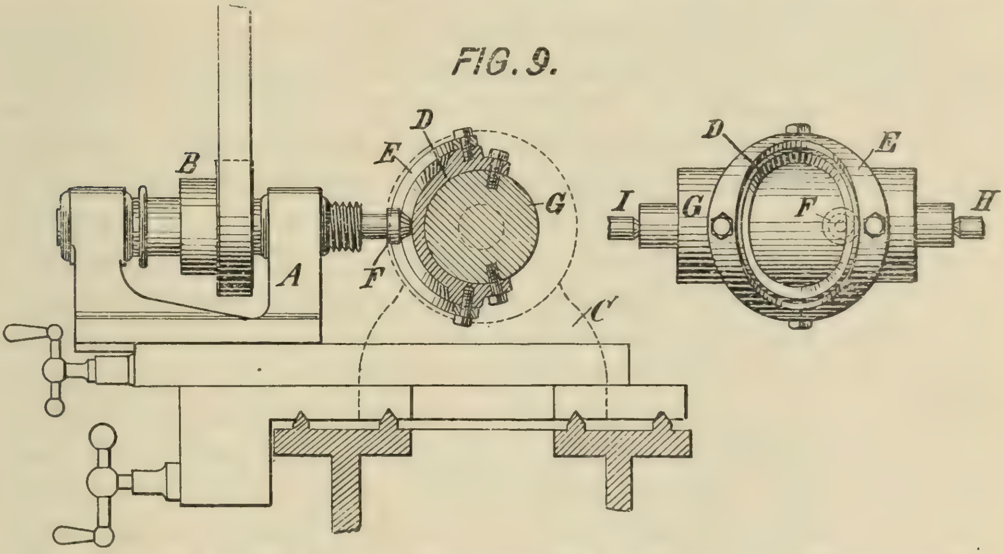
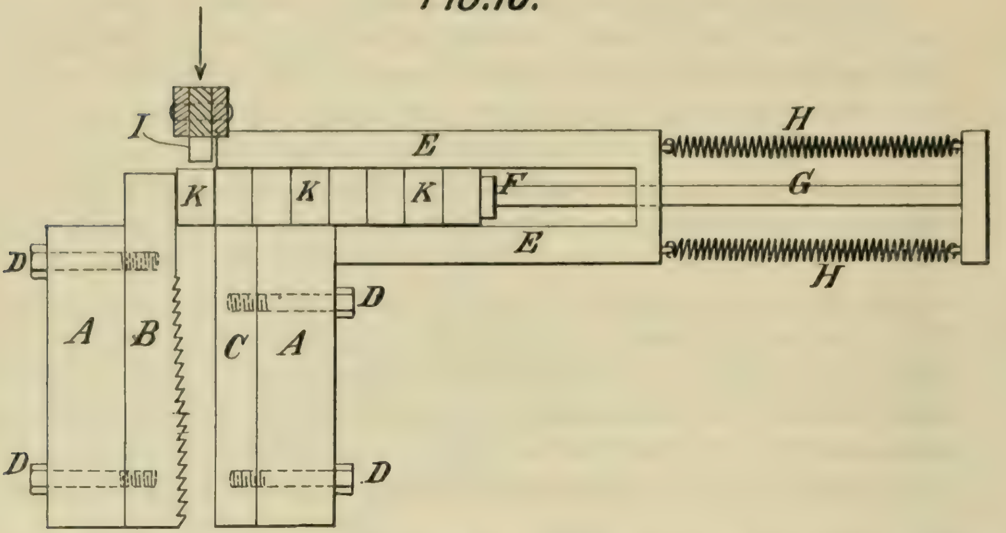


FIG. 10.



ing through the space between *B* and *C* the pieces *K* are shaved down to exact widths, and one can be finished and thrown out at each traverse of the pusher *I.* The edges of the cutter teeth are inclined slightly from the perpendicular, so that the tendency of the piece operated upon is downward toward the bottom of the space. For about one-third the distance from the exit end, the line of edges of the teeth is parallel to the guide *C*, and by means of the adjusting screw *D*, the width of the finished pieces can be gaged with great nicety.

I have thus presented a few of the resources for economies in special work that from time to time in the progress of a varied business during many years have enabled me to force a profit out of what at first seemed rather unpromising jobs; and I have done this with a view to help others. I do not believe much in "shop or trade secrets" as they are called. The attempt to hide from others what has proved successful, has often stimulated the invention of a more successful thing than the one concealed, ultimately making competition more unequal than the secret method did, and giving advantage to the side on which it was least desired by the concealer. I believe that when useful methods are known, their promulgator confers a public benefit, for which other and higher than pecuniary rewards will follow, and in this spirit I am always willing to respond to any one who makes inquiries, knowing that in the end I shall receive more than I can possibly impart.

THE OUTLOOK FOR SILVER MINING.

By Albert Williams, Jr.

DURING the turmoil of the monetary agitation of 1893 it was well-nigh impossible to persuade either party in that bitter controversy to look at the matter without strong bias, for there were direct personal interests at stake, and every thinking citizen in the United States had very pronounced views on one side or the other. Now that, for the immediate present at least, the financial status of silver seems to be settled, the rancor has given place to a more judicial tone of thought, and we are in a position to discuss the outlook for the industry of silver mining with some show of calmness.

The protracted discussion has made all more or less familiar with the history of silver—how in ancient times it was more nearly on a par with gold, standing at 3:1 in some countries; how in the middle ages it fluctuated within rather narrow ranges down to the time of the Spanish conquests of Mexico and Peru, when it stood at about 14:1; how during the first half of this century it hovered about 15½:1. The first serious decline came about in 1874 when the effect of the new monometallic policy of Germany, and the United States coining law of 1873, began to be felt. From that time on the downward progress was continuous and rapid, until in 1893 the average ratio was 26.49:1, and this year will show an even less favorable ratio. At the extreme depression it exceeded 30:1.

When the decline began in 1873–74 the great bonanza of the Comstock lode in Nevada had just been discovered, and a little later some remarkably exaggerated notions as to its importance began to spread; in fact there was one estimate of two billion dollars' worth of ore in sight! The prospect of a large output in some other silver-mining districts of the United States added to the alarm. Subsequently came the discoveries at Leadville and in other parts of the Rocky mountain region; followed still more recently by the opening of the great Broken Hill district in Australia and the reopening or working on a larger scale, with modern facilities, of various mines in Bolivia, Peru, and Mexico. It was inevitable that the continuous succession of new finds and the steadily increasing production should have had an effect upon the market prices of the metal. This effect indeed has, until quite lately, been cumulative. On the one hand was an augmented output; on the other a repudiation of silver for coinage by several countries which had previously pursued a bimetallic policy.

The two most important recent events affecting the price of silver were the closing of the Indian mints in June, 1893, and the annulment of the United States silver-purchase act of 1890, which was brought about November 1, 1893. These two changes took out of the market the two largest buyers of silver. The highest quotation in that year was $0.847 per troy ounce in January, and at the end of December it touched $0.664 per ounce. This year the price has been fairly steady, averaging a little above 60 cents, though it dropped temporarily below the 60-cent mark.

The course of prices suffices to explain the present depressed state of the industry. Few products can stand a drop of 50 per cent. in so short a time. True, almost all commodities except gold and some trifling exceptions have been falling; but the decline in silver was an extreme case.

The world's production, as already stated, has been rapidly increasing, but is now being checked. For the latter half of 1893 there was a marked falling off; and while no statistics for the current year are yet available, it is believed that there will be a considerable decrease in the output.

It is not necessary to go back for statistics further than the year 1873 —the critical period in the history of silver—for down to that year the price had remained for a long time practically stationary, with the exception of small changes caused by difference in exchange, or a greater or less demand from the Orient, at a figure closely corresponding to the ratios of 15½:1 or 16:1 maintained by the silver-using countries. The following table, compiled from the reports of the United States Bureau of the Mint, will show the relation between the total production and the gold ratio as measured by market price:

WORLD'S OUTPUT OF SILVER AND ITS COMMERCIAL RATIO TO GOLD.

	Production: Troy Ounces.	Ratio.		Production: Troy Ounces.	Ratio.
1873	63,267,000	15.92	1884	81,597,000	18.57
1874	55,300,000	16.17	1885	91,652,000	19.41
1875	62,262,000	16.59	1886	93,276,000	20.78
1876	67,753,000	17.88	1887	96,124,000	21.13
1877	62,648,000	17.22	1888	108,827,000	21.99
1878	73,476,000	17.94	1889	120,214,000	22.10
1879	24,250,000	18.40	1890	126,095,000	19.76
1880	74,791,000	18.05	1891	137,171,000	20.92
1881	78,890,000	18.16	1892	152,940,000	23.72
1882	86,470,000	18.19	1893	161,163,000	26.49
1883	89,177,000	18.64			

That is, in twenty years the annual output had more than doubled while the price had about halved. If silver were a commodity like wheat, or petroleum, consumed in whole from year to year, so that the consumption keeps pace with the production, these changes could be explained simply in accordance with the law of supply and demand—and would form a very apt illustration of the working of that law. It must not be forgotten, however, that besides the annual increment there is an immense accumulated stock, the result of mining for an indefinite period. What that stock amounts to cannot be stated with any close approach to accuracy, although statisticians have given much attention to the matter on account of its bearing on coinage questions. One guess is three billion ounces; but that may be very far astray, the main uncertainty being as to the amount absorbed and still existing in India, China and Asia generally. So here some modification of theory is necessary. If the estimate of three billion ounces is anywhere near the truth the annual increase during late years has been about one-twentieth of the amount of silver already held. The reduced demand for coinage purposes must therefore be held responsible for a large part of the decline—for a money metal has a somewhat different footing from other commodities in having what might be called an arbitrary demand for coinage in addition to its normal demand for consumption in other ways, the former being affected by legislation to a greater degree than the latter. Only forty years ago there was alarm lest the gold mines of California and Australia by their heavy output might not disturb the relative values of the two precious metals in the opposite direction from what has happened of late.

At present, unless all signs fail, silver is about at the bottom. It is hard to imagine what could happen to it to make its position worse, for the silver monometallic countries are in no condition to go upon a gold basis, if they desired to, nor can countries using large amounts of silver coin, in addition to gold, like France, afford to make a change. The customs of the various silver-using-nations have an influence. The money they are used to they will adhere to, unless under strong pressure to the contrary.

Assuming silver to have really settled down to bottom figures, there is the melancholy consolation of knowing the worst and having nothing further to fear. But is there no light in the future? What can be done? This is a problem of deep moment to silver miners and investors who are already interested in silver mines. The solution lies in three directions:

1. A larger demand for coinage, which is not likely to occur in the immediate future, unless the present sentiment of the world undergoes a very decided change.

2. An increased consumption in the arts, for plate and other tableware, ornaments, miscellaneous small articles for which it is adapted, etc. These are the principal outlets at present. The plating of pistols and similar articles, has been pretty thoroughly occupied by nickel, which though less pleasing to the eye has the advantage of not tarnish-

ing when exposed to sulphurous fumes. There has never been any effort on the part of producers to extend this industrial consumption, though the silversmiths are of course constantly doing so on their own account. It does not seem probable that any new line of consumption in the arts will be opened. The demand will doubtless always be mainly for the manufacture of the same goods now in favor ; and the amount of this demand depends upon whether people are prosperous or otherwise. As a country grows rich it tends to luxurious ideas, and with the return of better times there will probably be a greater demand for silver in the arts. On the other hand silver forms the jewelry of the poor, and an astonishing quantity has gone to form bracelets, anklets, etc., in India and China. At present the director of the mint estimates the world's annual consumption of silver in the arts at about 663,000 kilograms of the commercial value (of $0.78 per ounce in 1893) of $16,622,980, or about one-fifth the average annual production during recent years. This is an improvement over the industrial consumption in the time of Humboldt, who estimated that about one fifth the output of both gold and silver were thus disposed of, not separating the two, and probably estimating the greater portion as gold.

3. Another way in which silver mining might be placed on a more satisfactory footing is by reducing expenses. This is not very hopeful, but something might be done. There are but a handful of profitable silver mines compared with those in operation a few years ago. If the price of the metal is to remain stationary an effort to cut down costs still further must be made.

In discussing silver mines a common misconception must be corrected. Silver is so closely related in mode of occurrence to gold and lead and less frequently to copper, and even to antimony, zinc, and iron, that there are a great variety of "silver mines," some of which yield a third or more of their values in gold, some having lead in such quantity as to furnish acceptable ores to the smelters, who are always eager to buy good fluxing ores. The gradations are endless. Now in many instances the silver itself may be regarded as a welcome by-product rather than the main reliance, and during the hard times some of the mines have been enabled to live on in this manner. Altogether there are more mines producing, besides the silver, appreciable quantities of gold, or some other valuable mineral, than there are of straight silver mines. The latter have to be very rich to pay at present prices.

What it costs to produce an ounce of silver is a vexed question. If all the failures and hopeless undertakings, all the abandoned mines, are to be taken into account, the average cost must be very high. It is believed to be considerably over $1 an ounce. But the data are too deficient to allow of anything like reliable estimates. For single mines, and for some groups of mines or districts, figures are available, and they are not encouraging. Several mines which have paid dividends not long ago would have to suspend if silver dropped a very few cents. Mines that are operated at a constant loss either hold out some hope of a bonanza or the owners feel obliged to keep the pumps going to prevent flooding and the consequent ruin of the workings.

Machinery and supplies are cheaper and better year by year. These items can hardly be reduced in cost much more, in the near future, as competition has brought prices low already. Freight rates have also been cut down nearly as far as they can go, since the railroads in mining regions have to favor the mines, their main reliance. Wages will have to go lower. This item is the last one to be pared down ; but there seems no help for it. Every time an attempt has been made to reduce wages or increase hours the men have made a stubborn resistance, in some cases resorting to violence and destruction of property. They have one advantage over the mine owners ; they can turn to other pursuits, while the investors are often helplessly tied to their properties. Yet for the time being the men have difficulty in making a living when thrown out of employment in the silver mines that close. The general depression in the United States has been doubly severe in the silver-mining states. A process of readjustment has been going on, and those who could have turned to gold mining.

Metallurgical treatment has been slowly cheapening for years, but has now reached a point where there is not much margin for further reduction. Under the most favorable conditions it costs say $4 a ton for treatment of silver ores, whether by mill, smelter or leaching works. Any saving that can be made here will not be large. Still there will undoubtedly be small reductions in each of the items of expense mentioned in the line of changes that have been going on hitherto. However slight individually, these reductions count considerably in the aggregate. In another direction economy must be adopted—in the expenses at main offices of the companies, for rents, salaries, etc., which are almost always out of proportion to the importance of the mines.

But there is a point to which too little attention has been given ; the dressing of ore at the mines, by close hand-sorting and concentration. If the ore is of a character admitting of concentration, a mill for that purpose is very desirable for preparing ore for shipment to custom works. By bringing 5 or 10 tons into one, freight charges and cost of final treatment are reduced to one-fifth or one-tenth, the cost of mining and concentration being based on the gross tonnage. There is of course a loss in concentrating, sometimes heavy. But even if so, it may still be the best policy to concentrate before shipping, in many more cases w done. The miner must remember that the ore has to be regarded as only one item in his business and put on a level with timber, fuel, explosives, etc., as a raw material like his supplies ; indeed as one miner has said, " the ore is the cheapest thing we've got." In this light a loss in concentration appears allowable, if the final net result is bettered.

Exaggerated notions as to the value of silver mines and the facility of mining prevail among the outside public. Bonanzas are rare ; borascas frequent. In the management of a silver mine nowadays constant watchfulness to find and stop every little leak is necessary, to say nothing of technical skill. This holds as to the richest as well as to the poorest mines

While the depression has closed so many mines, in individual instances it has had the paradoxical effect of stimulating activity, to the end that the falling off in profits per unit may be partially compensated by larger gross earnings. On the whole the silver output of the United States and of most other silver-mining countries must show a decline for the current year as compared with former records. In this manner the check in the total production may be expected to have a good effect in stiffening prices, in accordance with the usual relation between supply and demand. That is, while the industry as a whole may continue to suffer, those producers who are able to continue operations may secure better prices for their output. In other words silver mining will in a greater measure become automatically regulating, precisely as nearly all other industries have been forced to become. This is not an unhealthy state of things. It is not by any means all that the silver miners would desire, but it is something. In former times the idea that there was any direct competition in silver mining did not obtain. Now it must be recognized. Indirectly, apart from the actual amount of bullion produced, a further beneficial effect will be to remove the impression that there is no limit to the quantity of silver that can be mined, that indefinite stores of it lie available in the ground waiting for some one to dig it up and dump it on the market.

A large advance in price however can hardly be expected for some time to come. Conditions would have to change largely to admit of that. Meanwhile miners will have to do some very close figuring to make both ends meet. This indeed they have long been doing, but the economizing will have to be sharper yet. It is fated that every industry has go through this hard experience. Gold mining is by no means exempt ; and possibly, taken generally, it has been conducted more economically than silver mining, for on the whole it has not offered the same chances for unexpected finds as silver mining, the ore bodies being as a rule more regular in size and uniform in grade.

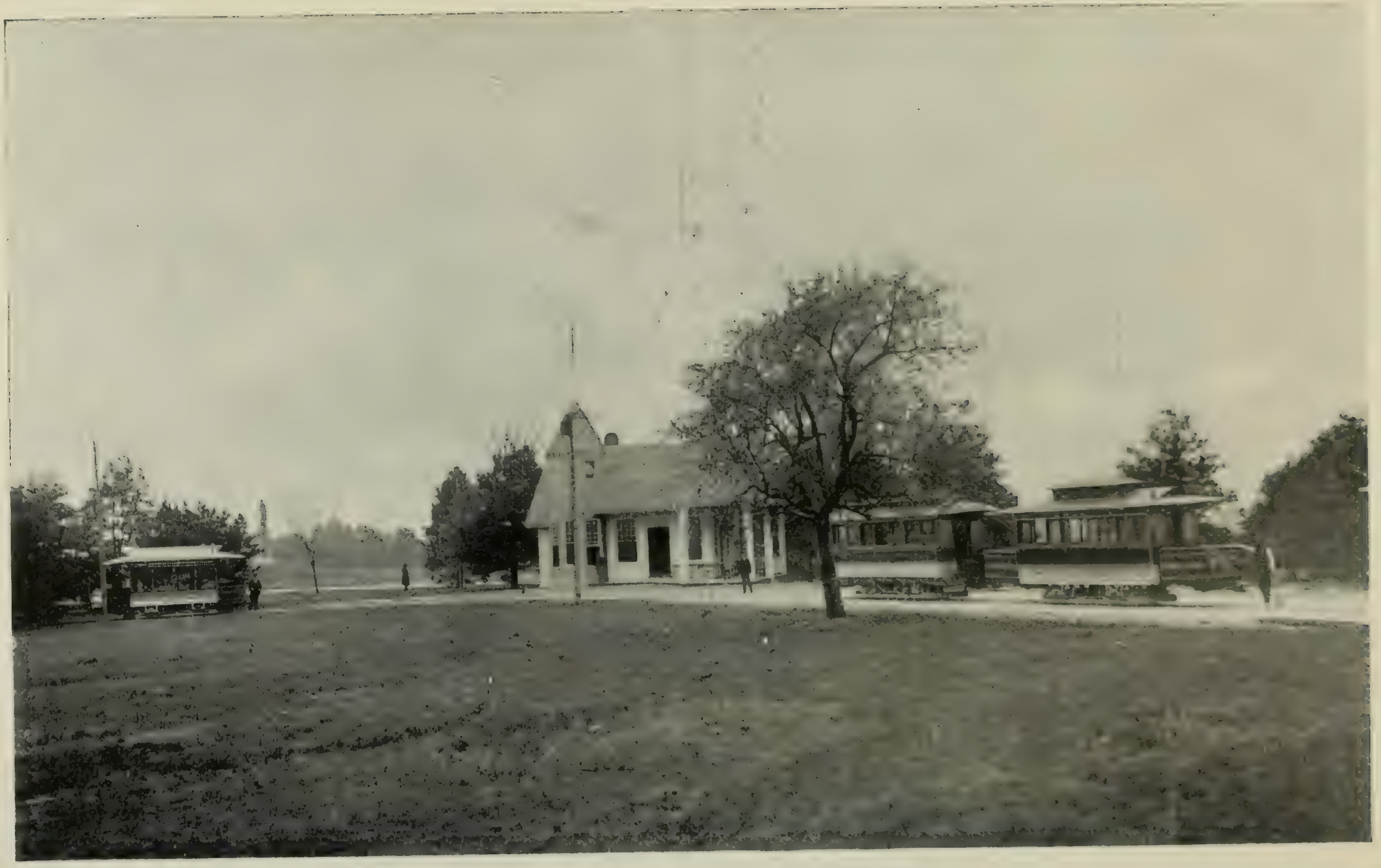
THE STREET RAILWAYS OF ST. LOUIS.

By William H. Bryan, M. E.

NO American city has had a wider or more interesting experience with the various forms of street railway construction and operation than St. Louis. Even in the early days of horse car lines she was progressive and liberal. As the traffic assumed more extensive proportions cable lines were extensively introduced, and she now takes front rank with the greatest amount and most improved forms of electric railways. This inland municipality has long called itself " The Electrical City " of America, basing its claims to the title not only upon its extensive arc and incandescent lighting plants—among the largest in the world—but principally upon the enormous extent to which electricity is employed in its street railway traffic.

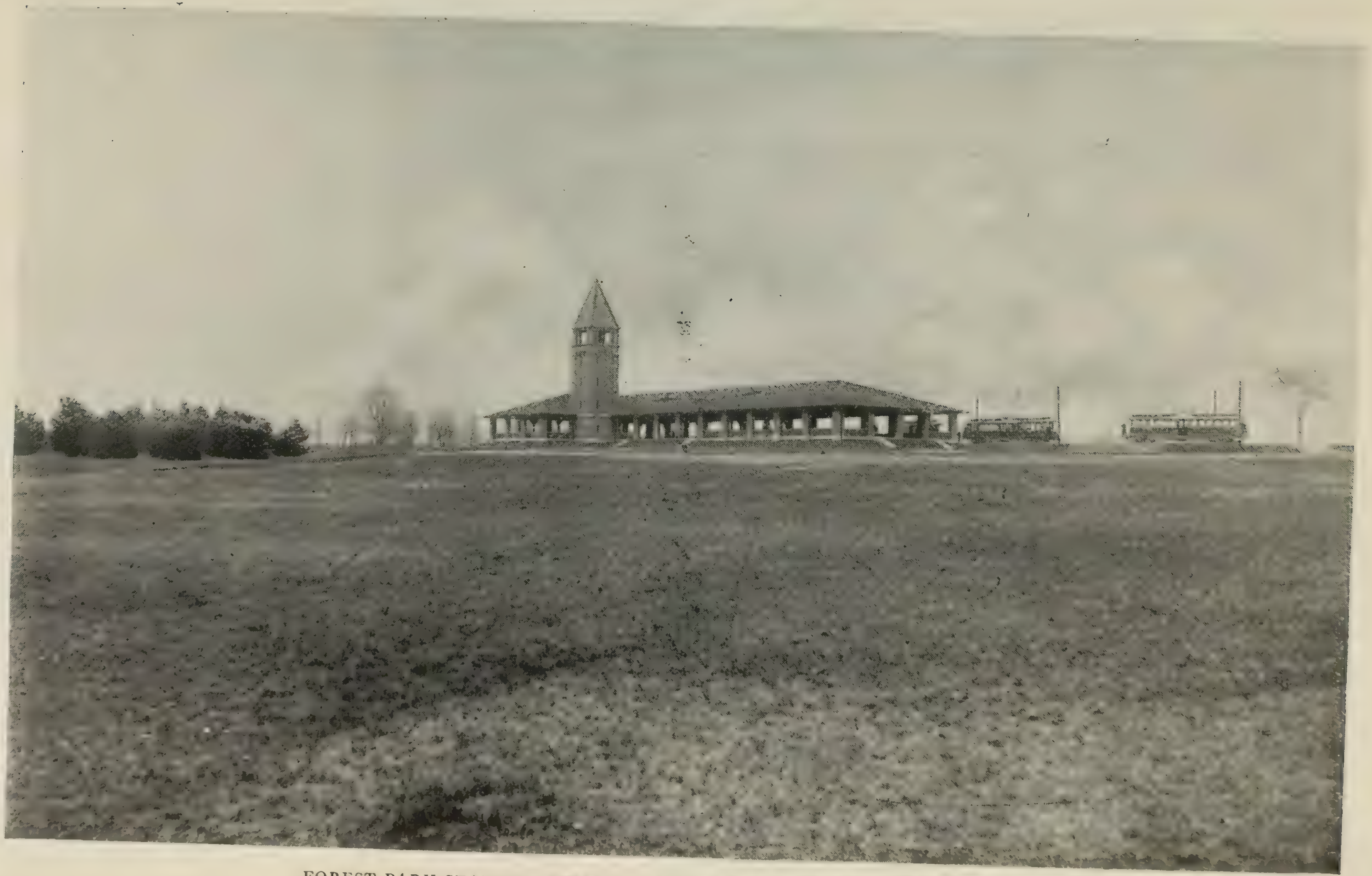
This preëminence of St. Louis is in large measure due to the far-sighted and liberal policy pursued by the municipal authorities in dealing with street railway companies. In this they have been supported by an intelligent and progressive public sentiment, which has insisted upon improved rapid transit, limited, of course, by reasonable restrictions as to routes, character of construction, speed, rates of fare, etc. St. Louis has been so fortunate as to escape the effects of the bugaboo of " the deadly trolley " in the hands of the sensational press. It has been shown beyond question that the electric car is one of the safest modes of travel, and is under absolute control. There have been accidents, it is true—some of them serious—but these necessarily accompany any improved system in the narrow and crowded streets of a great city. Since the days of George Stephenson rapid transit has necessitated not only increased skill and care upon the part of the operators, but greater caution on the part of all who use the public streets and highways. Although the people of St. Louis early recognized these facts, they preferred to accept the conditions imposed rather than remain indefinitely in primitive indifference, awaiting the development of an ideal system which should be absolutely dangerless.

St. Louis has neither the monotonous flatness of Chicago, nor the abrupt and often mountainous grades of Kansas City and San Francisco. Its traffic is not limited to a single line, as is that of the city of New York, but spreads in all directions from the business center to the west of a north and south line, the Mississippi river limiting the traffic eastward. The manufactories and railroads occupy almost the whole of the fourteen miles of river front, while the parks and resi-



FOREST PARK STATION, LINDELL RAILWAY.

[Showing Regular Trains Consisting of Motor Car and Trailer.]



FOREST PARK STATION, DELMAR AVENUE DIVISION OF LINDELL RAILWAY.

[Showing Long Double Cars in Use.]

dence districts lie to the west. The fare on all the lines is five cents, except for children. No forms of commutation or rebate tickets of any kind are sold. Recent combinations of different lines under consolidated managements have resulted in the widespread adoption of the transfer system, so that it is now possible to board a car at Calvary cemetery, in the extreme northwestern portion of the city, and ride with but one change of cars to Carondelet—a distance of some thirteen miles—for a single fare. Under such exceptionably favorable conditions it would be natural to suppose that many interesting and valuable street railway experiences have been had in St. Louis. It is the purpose of this paper to place some of these on record.

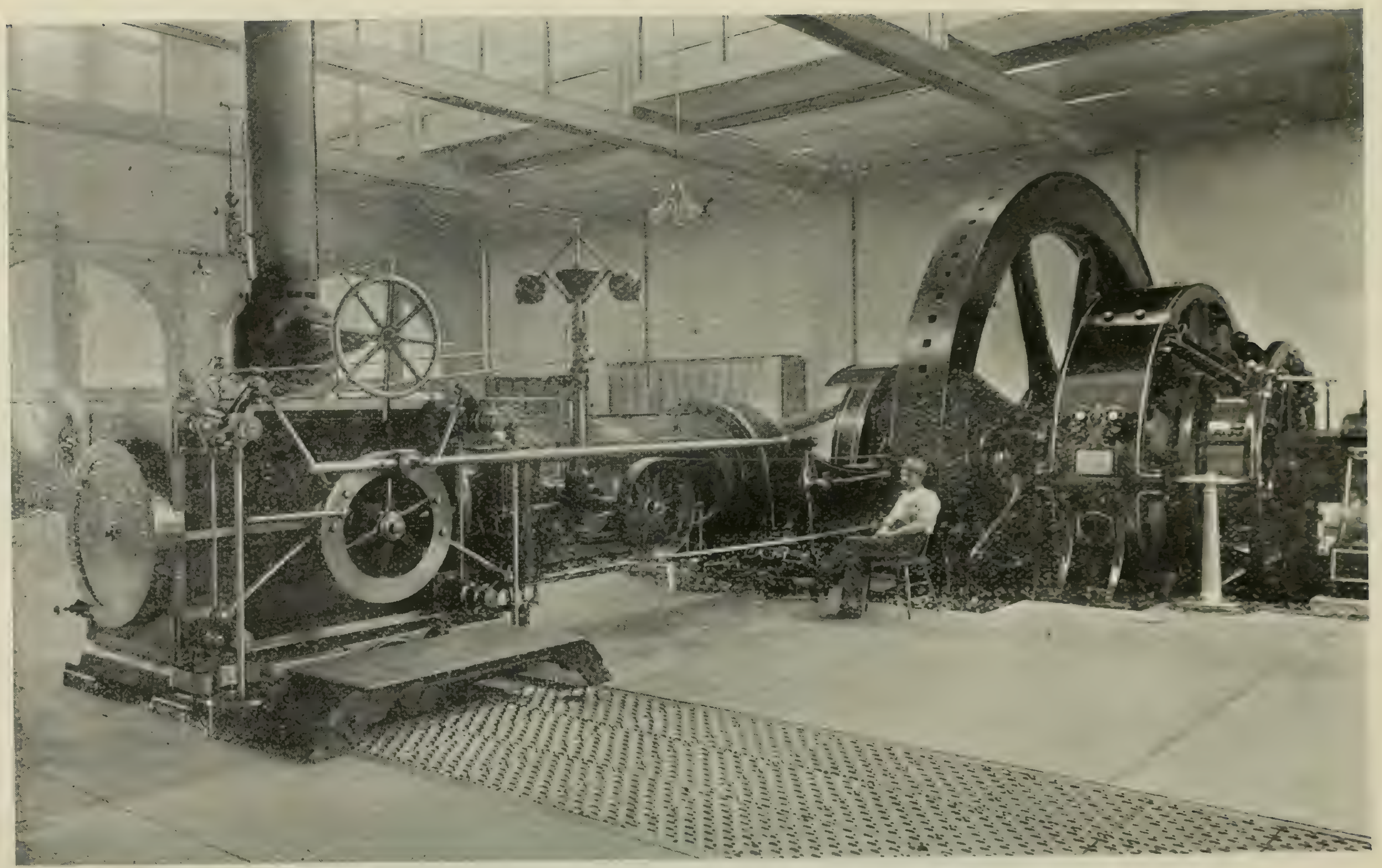
POWER HOUSE AND OFFICES, PEOPLE'S RAILWAY CO.

Not the least among them is the increase of travel which has followed the introduction of rapid transit, particularly with roads whose motive power has been changed from horse to electricity. It has not always been easy to account for this improvement. Competing lines suffer to some extent, but their losses do not account for all the gain. There is an increase in the grand total of travel, due no doubt to the adoption of better methods and more attractive surroundings. Rapid transit shortens distances, thus bringing together the residence and business districts, and building up outlying areas, hitherto inaccessible. It permits the man of modest means to enjoy the comforts of his own roof and his little plot of ground within reach of his office or shop. Who can tell how much has thus been added to the sum total of human happiness?

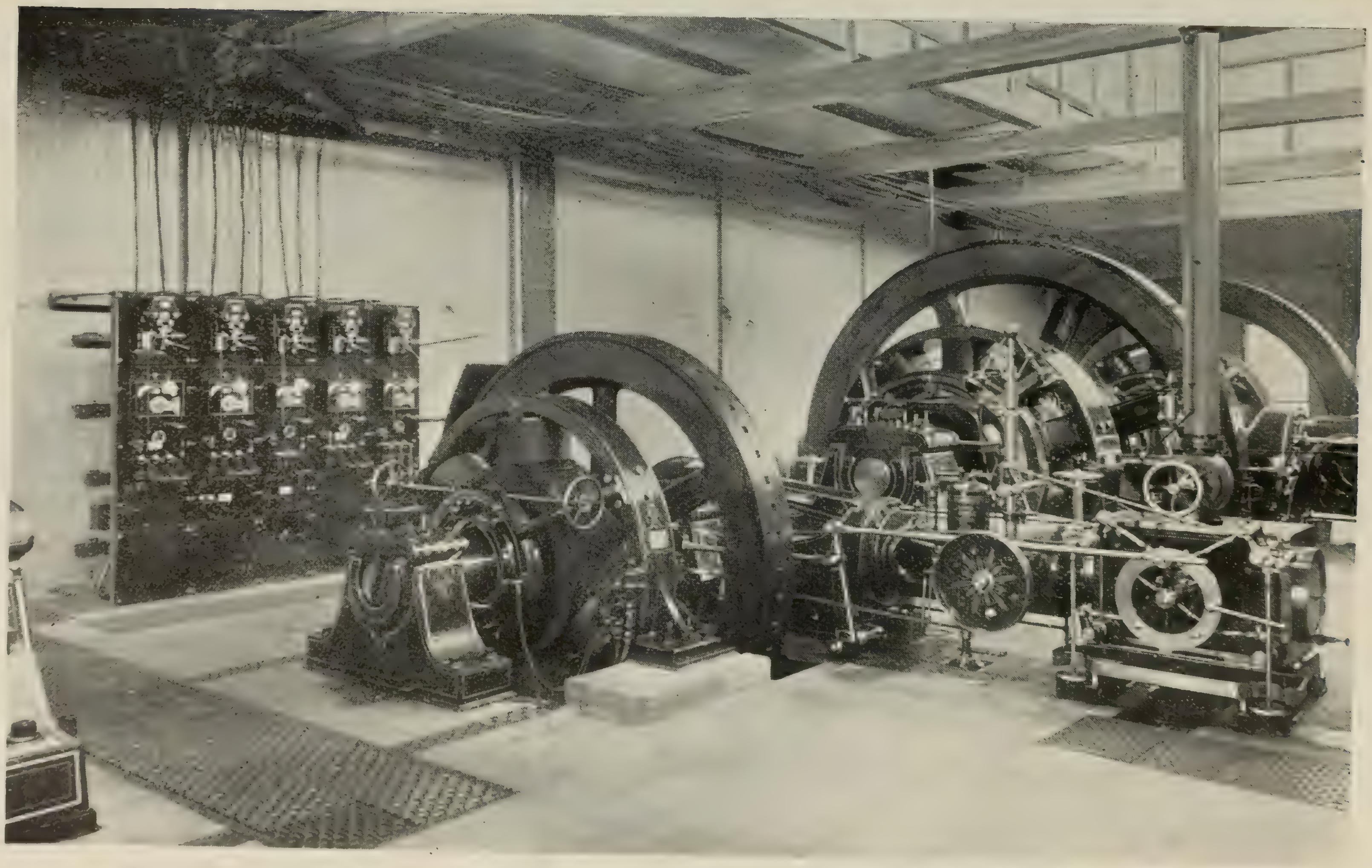
With more miles of electric road than any city in the world, and with an important showing of the most improved and modern cable line construction, St. Louis may well claim an advanced rank in rapid street railway transit. At this writing (September, 1894), the electric lines are as follows, in miles of single track:

CABLE POWER HOUSE, MISSOURI RAILWAY CO.

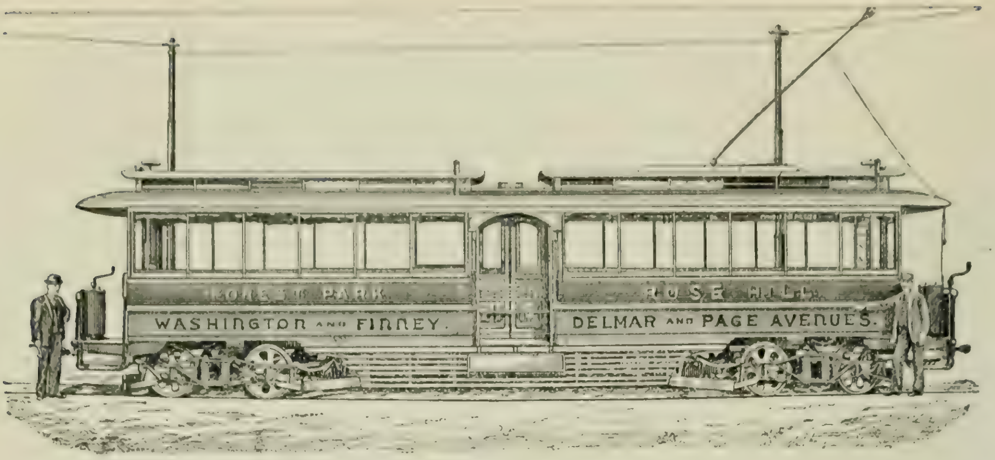
Union Depot system, including its Cherokee Division, Tower Grove Park, Carondelet, 18th street, Northwestern, Mound City, and Bellefontaine lines	63.80
Lindell Railway system, including its Forest Park, Page avenue, Vandeventer avenue, 14th street, Taylor avenue, and Compton Heights lines	48.25
Cass avenue system, including Cass avenue and Fair grounds, Northern Central, and Union lines	32.37
St. Louis and Suburban Railway, including its main double track line, its single track extension into St. Louis county, (10 miles) and its Forest Park loop	29.50



1000 H.-P. ALLIS ENGINE AND GENERAL ELECTRIC GENERATOR, CASS AVENUE AND FAIR GROUNDS RAILWAY CO.



SMALL CORLISS ENGINE, SPEED 150 REVOLUTIONS PER MINUTE, CASS AVENUE AND FAIR GROUNDS RAILWAY CO.



BAUMHOFF'S LONG CAR.

Missouri Railroad Co.	16.70
Southern Electric Railroad	15.67
Baden and St. Louis Railway	6.70
Citizens' Railway—Grand avenue branch	2.37
Total	215.36

The cable lines are the St. Louis Railway Co., 14.67 miles; People's Railroad Co., 10.10 miles; Citizens' Railway Co., 9.78 miles; Missouri Railroad Co., (now being changed to an electric line) 9.06 miles; total, 43.61 miles.

The horse lines are the Jefferson avenue, 5.70; Fourth street and Arsenal, 3.50; Citizens' Railway—Marcus and Easton avenue branches, 3.15; total, 12.35.

The total length of electric, cable, and horse lines, is 271.32 miles single track. Not a bad showing for a city of 600,000 inhabitants. Much of this track is used jointly by different lines. If the distances

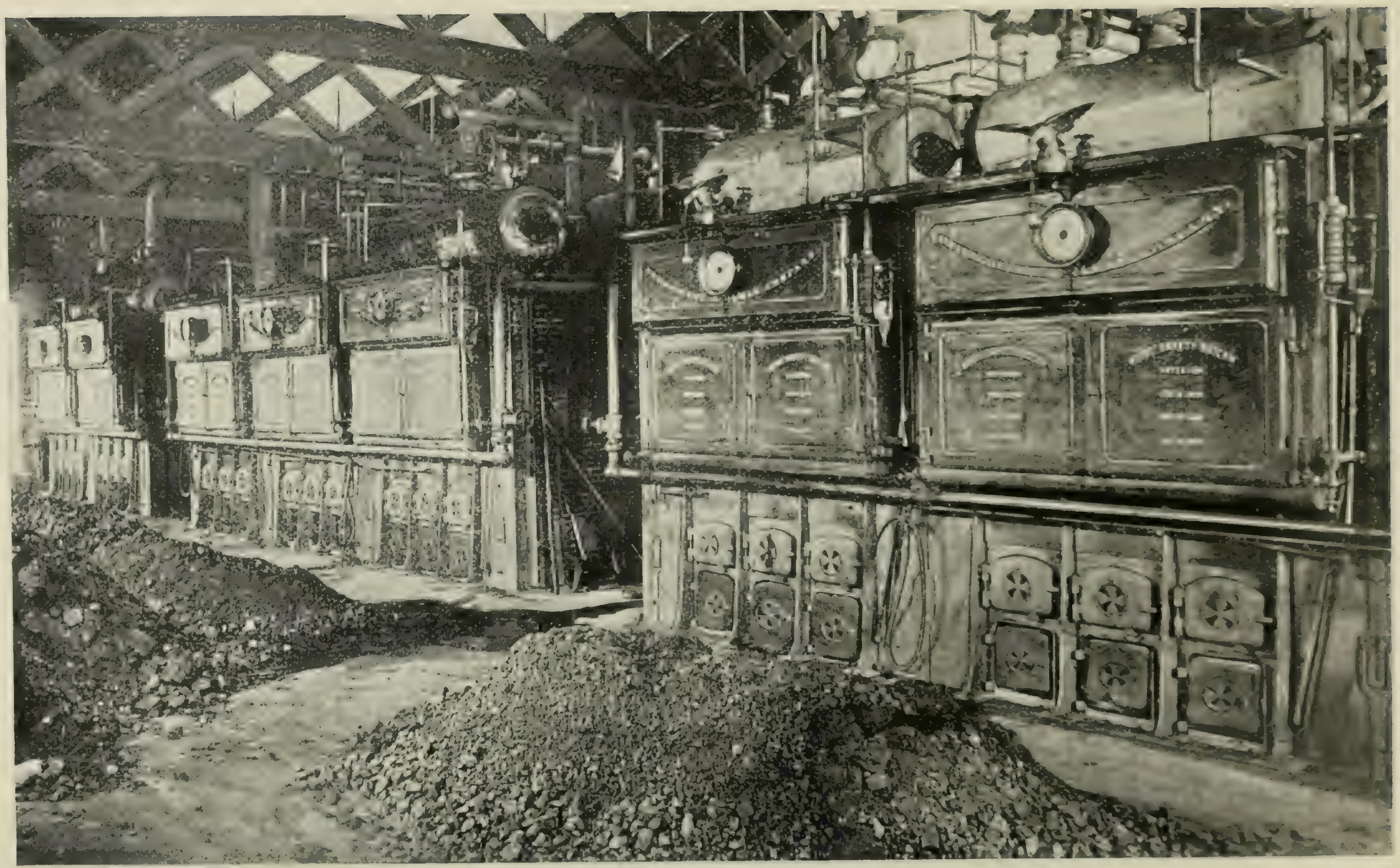
THE BROWNELL CAR COMPANY'S "ACCELERATOR."

were computed from the actual trip lengths, the total would be at least fifty miles greater. Legislation has been secured and plans are already practically complete for the change of the remaining horse roads to electricity. The last vestige of prehistoric modes of urban travel will then vanish, and the change from "mule to fuel,"—as it has been aptly termed, will be complete. Nor is new construction at a stand-still. The following electric extensions are now under way and nearing completion: Lindell Railway Co., 11.62 miles; Union Depot Railway Co.,—Grand avenue line, 8.00 miles; Southwestern Railway, 7.40 miles; Citizens' Easton avenue line, 1.66; Southern Electric Railroad Co.,—up-town extension, .89 miles; total miles single track, 29.57.

POWER HOUSE, UNION DEPOT RAILWAY CO.

The total business for all the roads covering the second quarter of the year 1894, as indicated by returns filed with the city register, was 1,433,421 trips, and 24,773,660 passengers. For the same period of the year 1893, the totals were: trips, 1,625,799; passengers, 26,186,742. This indicates the slight extent to which the traffic was affected by the widespread business depression of the year 1894.

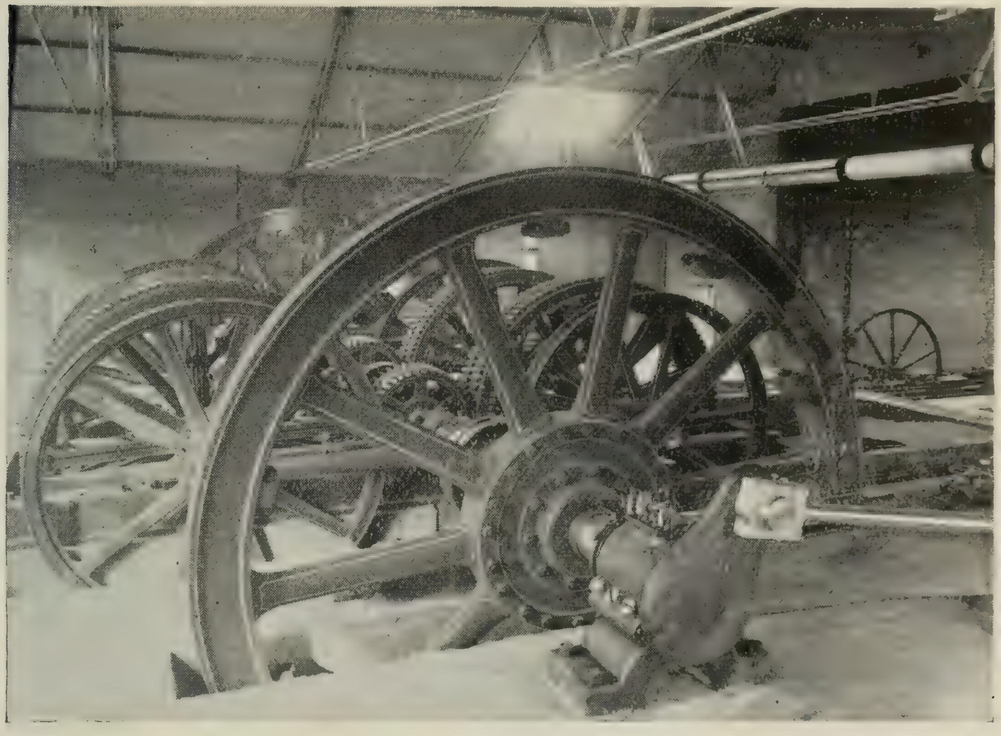
St. Louis has had little or no experience with other forms of motors. Nothing has been done, nor is likely to be done, with steam dummies, gas, ammonia, or compressed air motors. The lines are all on the surface. Franchises have been secured for elevated roads, but their great first cost and the doubt as to their improving to any great extent upon existing methods, has kept them from advancing into



HEINE SAFETY BOILERS. BOILER ROOM OF UNION DEPOT RAILWAY CO.

favor either with the public or capitalists. In the early days of the electric railway problem, the Lindell Railway Co. spent about six months in trials of storage batteries, using Brush-Julien cells. These experiments, however, were finally abandoned on account of the weight, excessive depreciation, low efficiency, and high first cost.

Several cable roads which proved unsatisfactory were changed to electric lines, with the result that they became successful at once. The St. Louis and Suburban, built in 1876, was operated originally as a narrow gage steam railway, over its own right of way from Grand avenue and Olive street to Florrissant, in St. Louis county. In 1885 the down town portion, from 6th and Locust streets, was constructed as a cable road. Being the first road of this character in the city it was immediately successful, and compelled prompt action on the part of parallel lines to secure rapid transit. The Suburban company's franchise was granted by an unfriendly council, and its right of-way was a round-about one, with many curves of short radius. Rapid transit on the more direct lines caused a falling off of its traffic, and the excessive operating expenses, due to the power required and the wearing out of cables, soon bankrupted the road. A reorganization being effected it was decided to reconstruct the entire line and equip it with electricity as the motive power.



POWER ROOM, ST. LOUIS RAILWAY CO., BROADWAY CABLE LINE.

CHIMNEY, UNION DEPOT RAILWAY CO.

This line was the first street railway in this country to be used regularly as a United States mail route. The service has been in very satisfactory operation for a period of more than two years. There is a full equipment of regularly furnished and specially fitted mail cars, which go over the entire route twice a day. These cars run on a regular schedule, and are due at definite times at certain corners, where mail is delivered to carriers for distribution over their respective routes. So successful is this service that it has been adopted in other large cities.

The Suburban is not the only road, however, which has found it wise to change from cable to electricity. The Grand avenue branch of the Citizens has undergone a similar transformation with the most gratifying results, and the main line of the same company is now being reconstructed.

POWER HOUSE, ST. LOUIS RAILWAY CO., BROADWAY CABLE LINE.

It has been possible in St. Louis to make comparisons as to the relative cost and operating expenses of cable and electric roads. The most recently built electric road is the Cass avenue system, which embodies the best features of modern electric railway construction. Among ths last cable roads constructed, was the Citizens, which was well built in accordance with the best practice of that day. These lines are operated under the same management, and an excellent system of records is kept by the company's engineer, Mr. Richard McCulloch, E. M. The conditions here are favorable for a fair comparison between the two systems. The number of cars operated, trips made,

MOTOR CAR, UNION DEPOT RAILWAY CO.

passengers carried, character and hours of travel, grades, and speed, are all of the same general character. If anything, the conditions appear more favorable to the cable than to the electric road, on account of the short length of the former, and the few curves. The records for the month of March, 1894, are as follows:

On the Citizens' (cable) line, the average number of trains (two-car) was 35, running each 107 miles daily. The horse-power per train, gross (including cable), was 18.32, and horse-power, net (exclusive of cable), was 6.38. Coal consumed per train mile was 11.18 pounds. Coal consumed per horse-power hour was 5.18 pounds. Water consumption per horse-power was 23.93 pounds. The average total load was 413 horse-power. The average friction load—cable only—was 2.69 horse-power or 65.13 per cent. of the total.

The engines are of the ordinary Corliss pattern, single cylinder, non-condensing. The boilers are of the horizontal return flue type, with 6-inch flues. The coal is the ordinary soft bituminous of southern Illinois, such as is used almost exclusively in St. Louis. It averages in calorific power about 10,500 British thermal units per pound, and 15 per cent. ash.

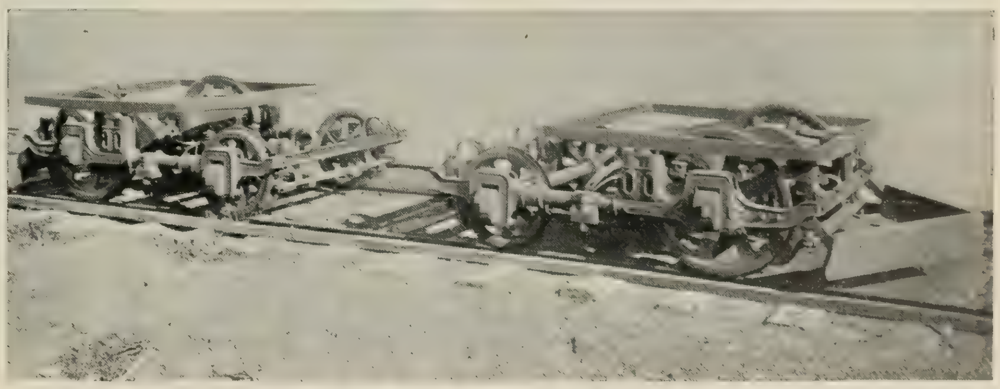
On the Cass avenue and Fair Grounds Electric Railway the average number of motors was 69, each running daily 125 miles, and 26 trailers, averaging 62 miles. The average horse-power per motor car was 15.52. The coal consumption per motor mile was 7.76 pounds. The coal consumption per train mile was 8.15 pounds. The water consumption per horse-power hour was 25.21 pounds. The coal consumption per horse-power hour was 4.22 pounds.

In computing these totals four trailers were assumed to be equivalent to one motor car. The latter are of the large single truck pattern, with 21 feet bodies and 7 feet wheel bases. Each is equipped with two 25 horse-power motors.

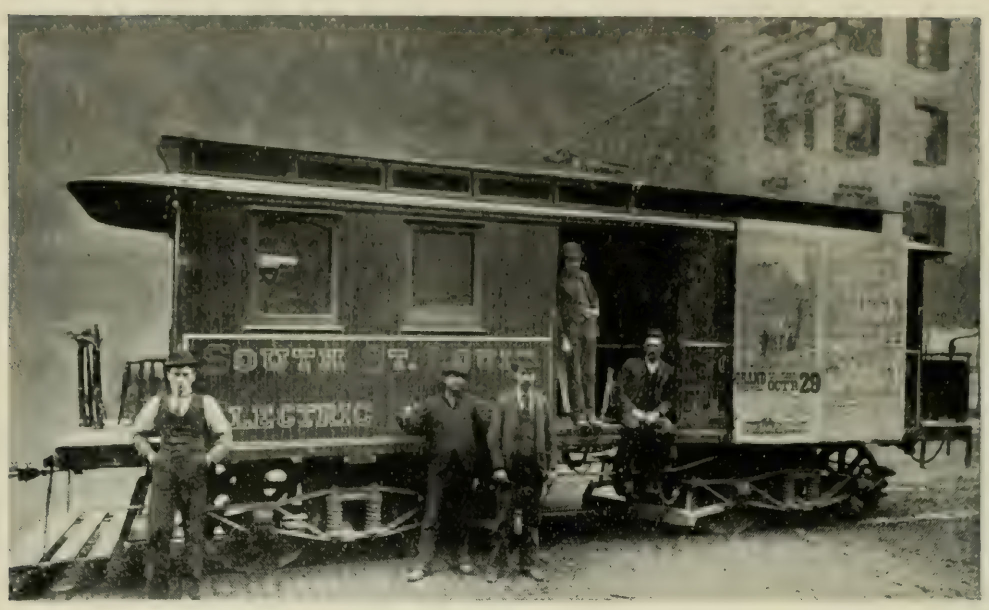
The engines are of the Corliss pattern, single cylinder, non-condensing. Three of them are 34 × 60, speed 92 revolutions, initial steam pressure 85 to 95 pounds, directly connected to 750 kilowatt multipolar generators. There is also an 18 × 36 Corliss running 150 revolutions, directly connected to a 250 kilowatt generator. The boilers are the same as at the Citizens' plant, except that they are set with down-draft smokeless furnaces.

The above figures show that the average horse-power used for each motor car is 15.52, and for each cable train 18.32,—a difference in favor of the former of about 15 per cent. It must not be forgotten, however, that the cable or friction load being constant, additional cable trains would require but 6.38 horse-power each, while additional motors would call for 15.52, considerably more than twice as much. The electric system, however, covers a mileage over three times as great as that of the cable. If the latter served as large a mileage, more length of cable would be required, and the power for the same number of cars would be greatly increased; while if the number of cars were enlarged at the same time, the power per car would be reduced to approximately the same figures given above.

These results, however, are from a single pair of roads. There are cable roads using less power per train, and there are electric roads using more. A considerable proportion of the saving in fuel is undoubtedly due to the better steam plant of the Cass avenue system, which requires but 4.22 lbs. of coal per horse-power hour, while that of the cable line consumes 5.18. Furthermore, the Cass avenue system is new in every part, while the Citizens' line has seen five years of very severe service, and as a result its operating and maintenance expenses have increased.



THE AMERICAN CAR CO.'S DOUBLE TRUCK.



SOUTH ST. LOUIS ELECTRIC EXPRESS CAR.

These figures point clearly to the conclusion that where a traffic exists sufficiently large to justify numerous trailers and close spacing, on a comparatively limited length of line, the cable is to be preferred. On the other hand, where the amount of track is extensive, and where the traffic per mile is less, electricity clearly has the advantage.

This, however, is not the whole story. Sometimes local conditions determine absolutely whether cable or electricity is the better. No electric road, whatever its traffic or extent of line, could operate successfully on such steep grades as are handled satisfactorily by the cable in San Francisco and Kansas City. On the other hand, such curves as are frequently necessary in St. Louis and Boston would prove disastrous to any cable line.

There are two troubles which seriously hamper the cable road. One of these, the closing of the slot in cold weather, has caused some of the St. Louis roads untold annoyance and expense. The other is the wearing out of the cable, and the expense attending its renewal. Now that the repairs to armatures have been reduced to only nominal cost, there are no corresponding outlays in electric railway work.

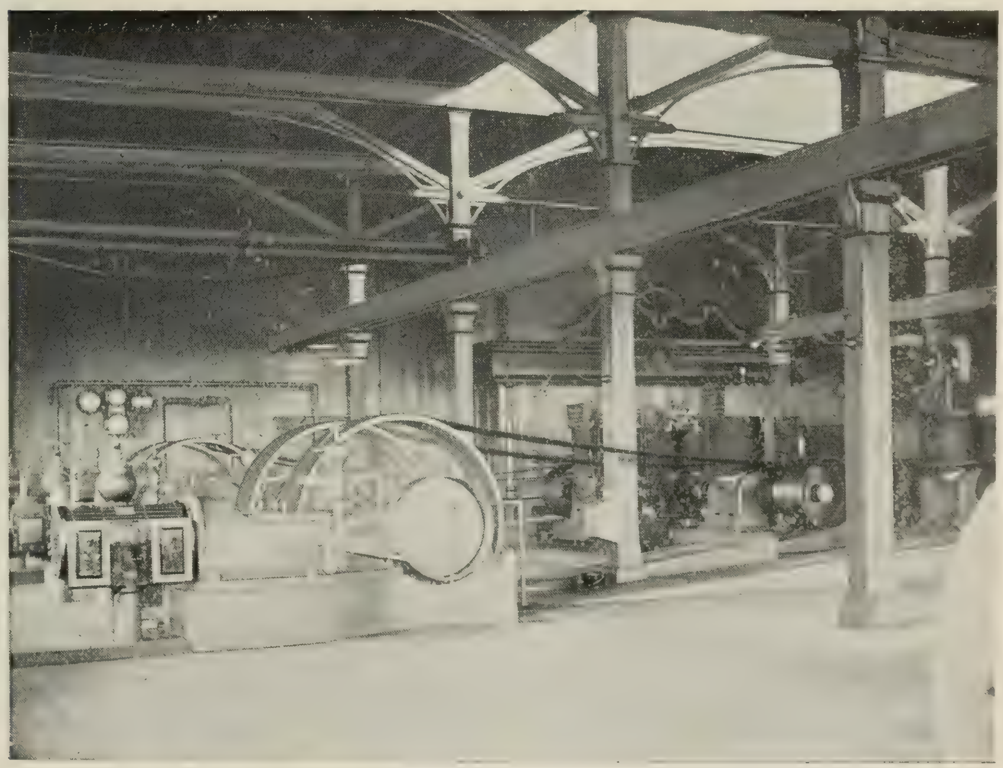
It would be difficult, if not impossible, to make up accurate tables showing the relative first cost, and the cost of operation of cable and electric roads; and when made, they would apply only to the particular roads to which they refer. In general it may be said that for roads operating more than twenty cars, the first cost of the electric plant complete is in the neighborhood of two-thirds of that of the cable, presuming the construction to be equally good in each case.

The experience of St. Louis roads indicates that the operating expenses are nearly the same, estimated at about 65 per cent. of the gross receipts. A new electric road has some advantages over an old cable road, while a cable line in good repair and with few curves, might show better results than an older electric line.

It is clear, therefore, that while certain general principles may be stated, no positive opinion can be given regarding a particular road, nor can a definite recommendation be made, except after a thorough study by a competent engineer of the local conditions affecting that special case.

A specially interesting feature of the Cass avenue plant is the high piston speed of the large Corliss engines—920 feet per minute; and the high rotative speed of the small engine—150 revolutions per minute, or 900 feet piston speed. Until very recently these rates have been considered inconsistent with reliability and durability, but these engines have now been in service for more than a year, and are doing excellently well.

The Southern Electric Railroad runs from near the Court House to the river Des Peres, in the extreme southern part of the city, eight miles distant, formerly the old town of Carondelet, but now within the city limits. The admirable service rendered has led to the

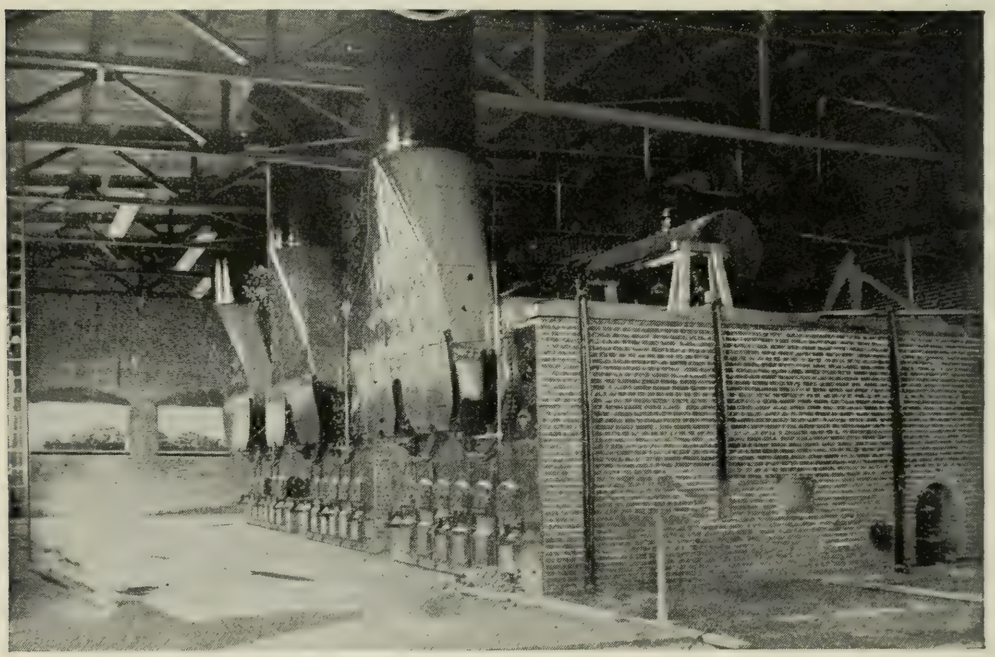


ENGINE ROOM, LINDELL RAILWAY CO.

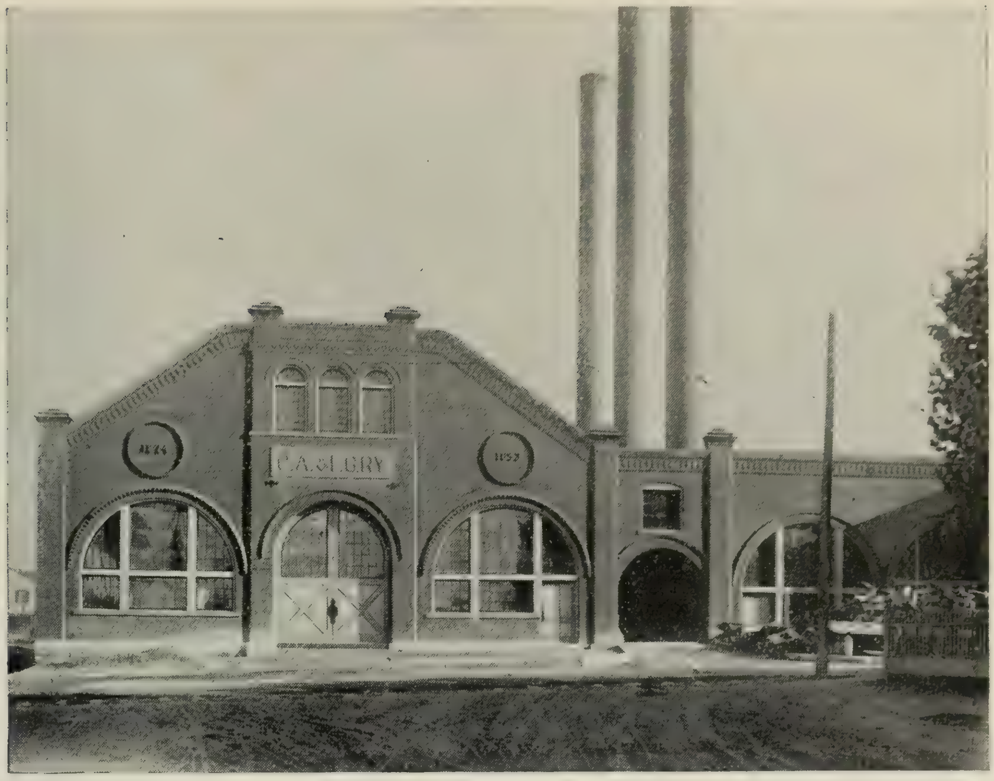
almost total discontinuance of the steam railway service, which was formerly the only means of communication. In addition, the Southern Company operates an express service, by means of specially arranged cars which make regular trips over the entire line at stated intervals. The company's delivery wagons bring goods to and deliver them from the uptown terminus. There are also two stations along the line at which delivery wagons take goods from the express cars and deliver them throughout the territory adjacent. This service has proved profitable to the company and satisfactory to its patrons. No line in the city has attempted any freight business.

A novel and interesting feature has just been added on the lines of the Union Depot system. The city health department has built an electric ambulance, which forms the principal communication between the city dispensary at the city hall and the various hospitals. The ambulance is specially fitted for the purpose, and is a model of convenience and elegance. Should this service continue to meet expectations it will be applied to other lines.

Electrolysis has caused the electric railways of St. Louis considerable trouble and expense. The system of distribution employed is the overhead trolley, with ground and rail return. The rails are well bonded, and in many cases supplemental return wires have been laid and ground plates buried in permanently moist earth at frequent intervals. These have always been deemed sufficient, the resistance of the earth return having been supposed to be negligible. The fallacy of this belief has,



BOILER HOUSE, ST. LOUIS AND SUBURBAN RAILWAY CO.



POWER HOUSE, CASS AVENUE AND FAIR GROUNDS RAILWAY CO.

however, been repeatedly demonstrated of late. The return current, dividing itself among the different channels available, in the inverse ratio of their respective resistances, finds ready paths in the water and gas mains. This of itself would not be particularly objectionable if it were possible to control and confine the current within these lines. Near the power plant, however, the current must leave these channels and return to the generators, and it is here that electrolytic action is the most manifest. In many cases the losses due to the eating away of the pipes have been disastrous and costly. The evil has been reduced to some extent by connecting the rails to the gas and water mains at frequent intervals, and running specially heavy conductors from them to the generators at the station. A further remedy lies in the addition of return circuits connected frequently with the rails. In several cases it has been recommended that as much, or even more, copper be provided for the return as for the feeders, but this can only be a partial remedy. As long as a number of paths are available, each will carry such portion of the current as its relative conductivity determines. While we continue to use the ground for the return, gas and water mains will carry some proportion of the current, and some degree of electrolytic action will follow. The only complete remedy is to do away with the ground return—a prospect by no means inviting.

MOTOR CAR, ST. LOUIS AND SUBURBAN RAILWAY CO.

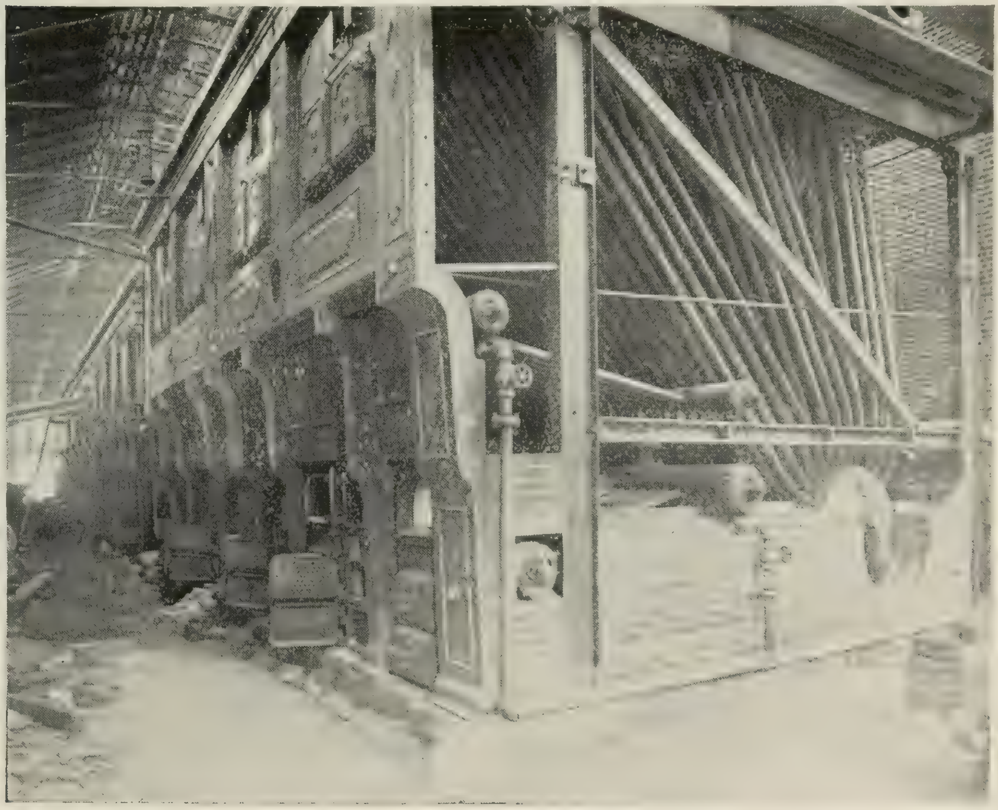
This brings up the question of welded rails, which usually have a cross section of far greater carrying capacity than the overhead feeders. This will largely reduce the electrolysis, and while it will not wholly stop it, it will usually bring it within such small limits as to be no longer serious.

The Baden extension of the St. Louis Railway Co. has just been completed with all the joints welded according to the standards recently adopted by the Johnson Co., of Johnstown, Pa. The line consists of two tracks each 3.35 miles long. Thus far no troubles have developed, and it is not believed that the expansion and contraction will cause serious difficulties. Only a small number of joints have thus far broken, less than one per cent. In every instance the break was traced to a defective weld, due no doubt to the inexperience of the operators handling the apparatus. It will be interesting to observe the condition of this track after it has passed through the winter.

Most of the large cable and electric plants are situated well out in the residence districts, and the smoke from their chimneys, resulting from the use of our soft bituminous coals, became quite a nuisance at one time. The city has recently passed a stringent smoke abatement ordinance, which is being rigidly enforced. This has resulted in the development of numerous improved types of boiler setting, and at present none of these chimneys are serious offenders. Some of them present an almost absolutely clean appearance at all times.

Lying within eight miles of St. Louis on the east is the western edge of the extensive coal fields of southern Illinois, from which a large part of the fuel supply of the Mississippi valley is drawn. At each of these mines there is a considerable proportion of slack or coal dust, which it usually does not pay to market. If sold at all, it is at the bare cost of handling, and sometimes at even less in order to get it out of the way. There is no reason why the large street railway power plants of this city should not be removed to these coal lands. The wonderful developments recently made in multiphase apparatus brings this plan clearly within the range of commercial possibility. The fuel cost would be almost entirely wiped out, and the loss in transmission can (by the use of step-up and -down transformers) be kept within quite reasonable limits, without excessive investment in copper. The plan is quite as practicable as that at Niagara, and the conditions are much more favorable. Not only would this part of the smoke nuisance be effectually obliterated, but the economical results, due to reduced fuel cost, concentration of machinery under a single management, improved arrangement, ample ground space, air, and light, with reduced cost of labor, taxes, and insurance, are all of the greatest importance.

Possibly when the consolidation of all the street railways of St. Louis is effected—a scheme which is even now being worked out—we may hope to see some progress in the direction of utilizing these immense sources of power now going to waste.



STIRLING BOILERS WITH DOWN DRAFT FURNACE IN NEW POWER HOUSE OF LINDELL RAILWAY.

GENERATING ELECTRICITY BY WINDMILLS.

By Lieutenant I. N. Lewis.

"Windmills lend revolving animation to the scene."—*Hood.*

THE problem of controlling and utilizing the so-called waste forces of nature has never occupied the prominent position before the industrial world that it does to-day, nor has it ever received such intelligent consideration and study.

The wholesale destruction of our forests, the failure of many of our gas and oil wells, and the great annual increase in our already enormous coal consumption, warn us that the fuel supply of the world is being rapidly exhausted.

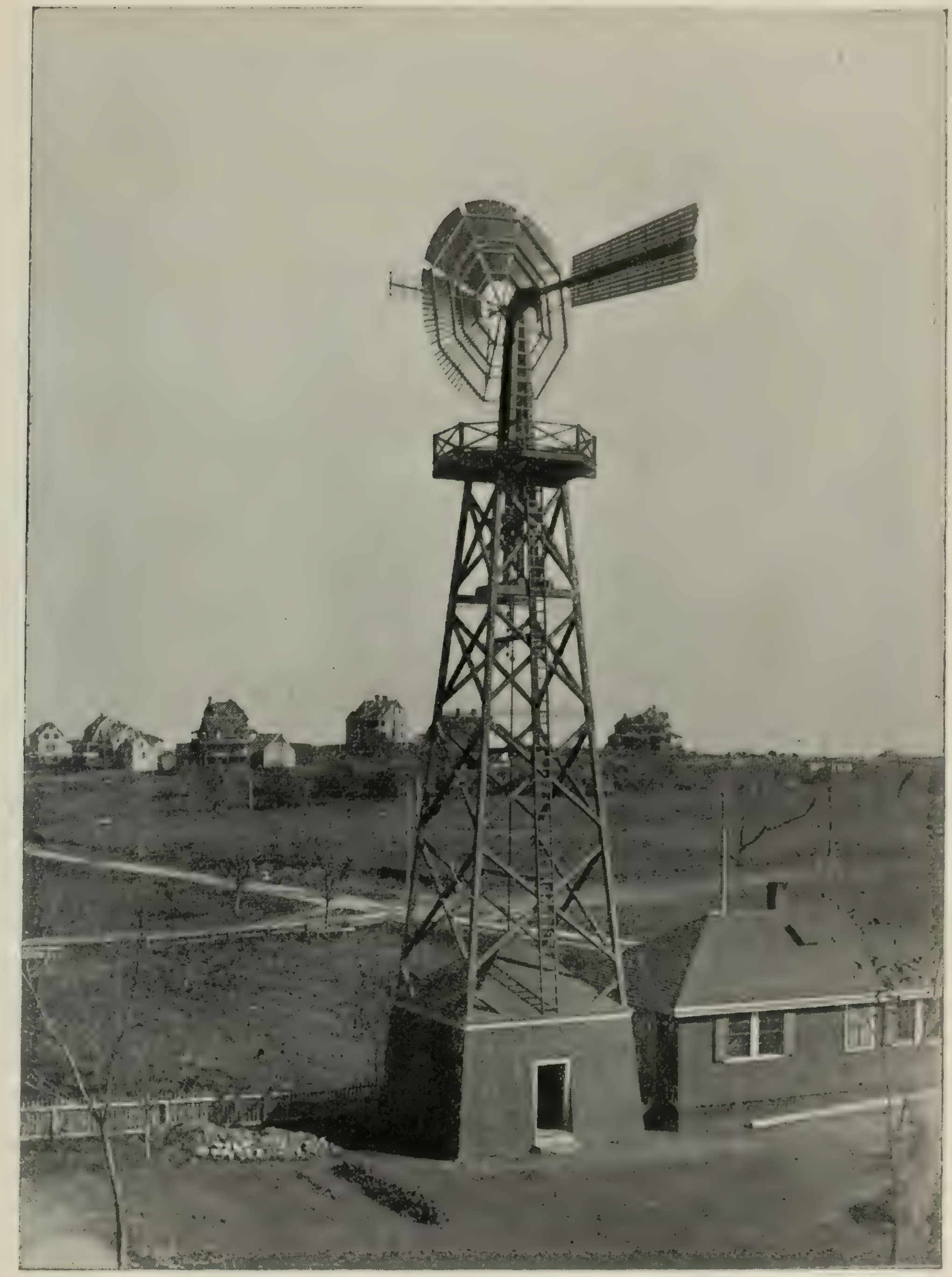
The steam-engine is so closely associated with every element in our nineteenth century civilization that it may almost be credited with having made this civilization possible. Recognizing this, we are slow to consider what an extravagant worker the steam-engine really is, and how absurdly large is the amount of fuel consumed, in proportion to the useful work done. The waste has been going on for so many years that we accept its necessity as a matter of course. Yet each pound of fuel thus consumed is one pound taken from that great store of potential energy which past ages have so bountifully provided for the comfort and well-being of the present one—a store which once exhausted, can never be replenished.

Perhaps the genius of a Tesla guided by the researches of modern electro-chemistry, may yet discover some practical, economical way to change the potentiality of coal directly into electricity, without the useless heat wastes involved in present methods. If so, there will be a postponement of the inevitable.

But in the meantime, how is the ever increasing demand for *cheap power* to be met?

I believe a partial answer to this query is to be found in that magnificent power-plant now nearing completion at Niagara.

Up to the time of the introduction of steam, the two great natural forces of wind and water were the only ones available to man for power purposes. Both the windmill and the water motor were, therefore, used to a considerable extent for such heavy work as could not well be done by hand. The crude processes and tools of the day, combined with a general ignorance of the laws of mechanics, prevented their development, and it is only within a very recent period that either of these motors has been brought to a perfection of mechanical detail sufficient to entitle it to be considered a commercially efficient machine.

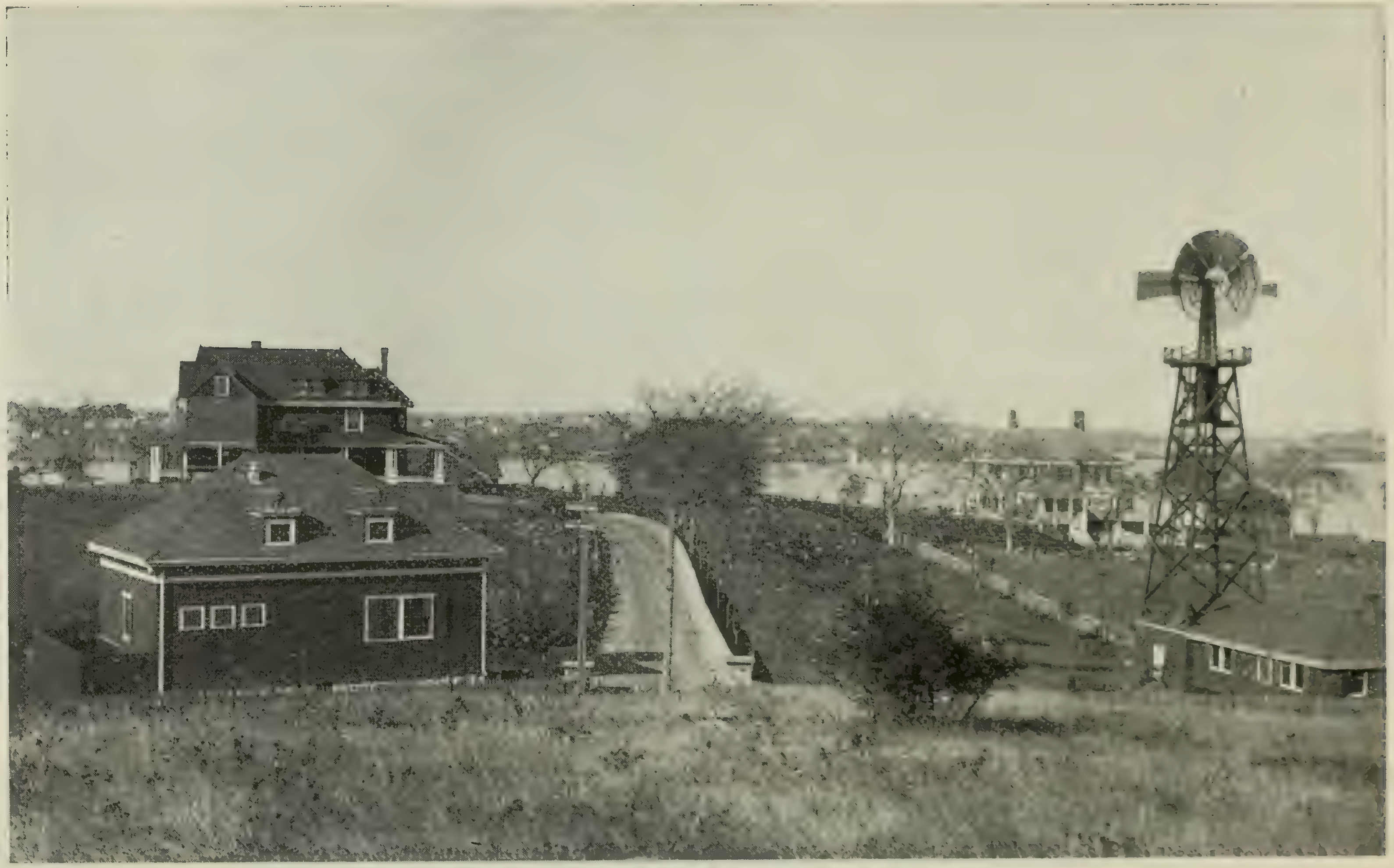


ELECTRICITY FROM WIND POWER—LEWIS SYSTEM.

[Windmill at Marblehead Neck, Mass.]

The water motor has been accorded its proper place in the list of prime movers; why should the windmill be so generally ignored?

It is true, the wind is the most inconstant, the most erratic, of nature's forces; in many respects it is the least to be depended upon, and



ELECTRICITY FROM WIND POWER—LEWIS SYSTEM.

[Summer residence of Mr. Geo. E. McQuesten and Col. Elbert Wheeler, Marblehead Neck, Mass.]

the most difficult to control; but, granting this, it constitutes such a vast natural reservoir of power that its real importance in this respect must soon be recognized by the engineering profession.

A history of the windmill itself, however briefly sketched, would be out of place in this paper, since I must confine myself more particularly to a single one of its many useful applications; but it will no doubt be of interest to the reader, and will give him some idea of the present magnitude of this industry, to learn that there are more than one million windmills in actual operation in the United States alone. Twenty different firms are engaged in the manufacture, and their combined sales exceed one hundred thousand mills each year.

The use of windmills for generating electricity, was first suggested by Sir William Thompson in 1881.

In his presidential address "On the sources of energy in nature available to man for the production of mechanical effect," delivered before Section A of the British Association for the Advancement of Science, in that year, this distinguished English physicist brought this subject before the scientific world in the following significant language:

> "When we look at the register of British shipping and see 40,000 vessels, of which about 10,000 are steamers, and 30,000 sailing ships, and when we consider how vast an absolute amount of horse-power is developed by the engines of those steamers, and how considerable a proportion it forms of the whole horse-power taken from coal annually in the whole world, and when we consider the sailing ships of other nations which must be reckoned in the account, and throw in the little item of windmills, we find that even in the present days of steam ascendency, old-fashioned Wind still supplies a large part of the energy used by man. . . . The subterranean coal stores of the world are becoming exhausted, surely and not slowly, and the price of coal is upward bound. When the coal is all burned, or long before it is all burned, when there is so little of it left, and the mines from which that little is to be extracted are so distant, and deep, and hot, that its price to the consumer is greatly higher than at present, it is most probable that windmills, or wind motors in some form, will again be in the ascendant, and wind will do man's work on land at least in proportion comparable to its present doing of work at sea. Even now it is not entirely chimerical to think of wind superseding coal in some places for a very important part of its duty—that of giving light. Indeed, now that we have dynamos and Faure's accumulator, the little want, to let the thing be done, is cheap windmills. . . . The probable cost of dynamo and accumulator does not seem fatal to the plan, if the windmill could be had for something comparable with the prime cost of a steam-engine capable of working at the same horse-power."

Words such as these, coming, as they did, from the most eminent, as well as the most conservative, scientist of the day, naturally attracted wide attention both in Europe and America. The question was taken up in the technical press, and was frequently discussed by electrical and mechanical experts in both countries, but nothing in the way of practical demonstration was attempted for some years.

In fact the time had not then arrived when a practical demonstration could be made with even a fair probability of success. Windmills, thirteen years ago, were costly and inefficient, the dynamo was still largely in the experimental state, badly designed and constructed, while the storage battery was viewed with distrust on account of its failure to realize immediately all that had been predicted of it in the first years of its introduction. The conclusion reached by the majority of those who made a study of the problem, was to the effect that such a system of lighting could never become a commercial success because of the excessive first cost, and the difficulty of adapting the electrical apparatus to such a variable and inconstant source of power.

Some five years later, M. Charles de Goyon, a Frenchman, conceived the idea of using wind motors on a large scale to charge accumulators, and then distributing the current to small land owners and cultivators at a fixed price. His experiments, however, proved expensive and the attempt was soon abandoned.

The next year (1887) an engineer, M. Beaumanoir, was authorized by the minister of public works in France, to establish a windmill and the necessary electrical apparatus, at Cape de la Heve, for the purpose of supplying electric light to one of the large lighthouses on that promontory. This plant deserves more than passing mention, not only because of the success attained, but the rather because it suggests a most important future field of usefulness for windmill electric lighting. M. Beaumanoir selected, as best suited to this work, an American Halladay mill, of the largest size then made. This he mounted upon a heavy tower of oak, with a masonry foundation. The electrical apparatus was placed in a small building at the foot of the tower, the main vertical shaft of the mill being connected by bevel gearing to a horizontal counter-shaft within the building.

Recognizing from the first, that the greatest difficulty to be overcome, would be to operate the dynamo safely at the widely varying speeds to which it would naturally be subjected, M. Beaumanoir hit upon the novel expedient of using alternately, two dynamos of different capacities. The dynamos selected were slow-speed, 75-volt Brush machines of the old Victoria type, each provided with an automatic field rheostat, and an automatic device for shifting the brushes. The smaller machine was rated at four horse-power, while the larger had a capacity of sixteen horse-power, or, sufficiently great to utilize the maximum power developed by the mill in the strongest wind. As both dynamos were operated from the same counter-shaft, a rather complicated arrangement of clutches and gear wheels was necessary in order that while one dynamo was at work the other would be idle.

In light winds, the smaller dynamo did the work of charging the battery, the current out-put gradually increasing, as the wind increased in force. When this current reached a predetermined maximum of 40 amperes, an automatic switch, operated by the current, threw out the smaller dynamo, and, at the same instant, threw in the larger one. The storage battery consisted of 32 cells, of sufficient capacity, when fully charged, to furnish the necessary light for three consecutive nights.

This plant was in practical operation for some considerable time ; but just how long, or with what degree of success, I have not been able to learn.

Within the past three years the question of using wind power to produce electricity has been revived in England, and one or two small experimental plants are said to be in operation there at the present time, but there are no published data at hand concerning them.

In the United States, the history of windmill electric generation would be practically all included in a history of the single elaborate plant erected by Mr. Chas. F. Brush, at his city home, Cleveland, Ohio, in 1887, and which is still in entirely successful operation.

Only a brief general description of Mr. Brush's work in this field will be attempted, but it is certainly no exaggeration to say that his is the most ingeniously designed, the most carefully worked out, and complete,—the most thoroughly unique, private electric plant in America. Every contingency is provided for, and the entire apparatus, from the huge 56-feet wheel of the mill, down to the most delicate electrical device, is automatic throughout.

The windmill tower is a closed, rectangular structure, 60 feet in height, pivoted upon a single wrought iron gudgeon, 14 inches in diameter, which extends some 8 feet below the level of the ground in solid masonry. The whole tower with its contents, consisting of shafting, pulleys, belts, dynamo and fittings, etc.,—the total weight of which exceeds 80,000 pounds,—not only rests upon the gudgeon, but is free to revolve about it as a vertical axis.

In the upper part of the tower is journaled the main wheel shaft of steel, 20 feet long and 6½ inches in diameter, with self-oiling bearings 26 inches in length. This horizontal main shaft carries the main driving pulley, 8 feet in diameter, with a face 32 inches wide. A counter-shaft arranged just below, and parallel with the main shaft, carries three pulleys ; the middle one receiving the main driving belt, while the two end pulleys are belted directly to smaller pulleys, one at each end of the armature shaft of the dynamo. The relative diameters of these different pulleys are such as to make the armature speed of the dynamo 50 times that of the mill wheel. The dynamo does not rest upon a solid support, but by a novel arrangement of counter-weights it is partially suspended by the two driving belts, only so much of its weight being allowed on the belts as is necessary to prevent them from slipping.

The dynamo, one of Mr. Brush's own design, is provided with an automatic switch to throw the machine into effective action when the speed reaches 330 revolutions per minute, and an automatic regulator which prevents the voltage rising above 90 volts at any speed. The working circuit is arranged to close automatically at 75 and open at 70 volts. The brushes of the dynamo rock automatically as the load changes. The field is slightly compounded. The normal electrical out-put at full load is 12 kilowatts, which requires the mill to develop at least 24 horse-power.

The current generated passes to steel contact shoes, which slide upon annular plates surrounding the gudgeon as the tower turns with the changing direction of the wind, and thence by underground conductors to the storage battery in the basement of Mr. Brush's house.

The battery consists of 408 cells of 100 ampere-hours capacity, arranged in 12 groups of 34 cells each. These groups are charged and discharged in parallel. The containing jars are of glass, and the liquid in each is covered with a film of oil, thick enough to prevent evaporation and spraying. The basement room containing the battery is a veritable electrical laboratory. The list of electrical instruments in daily use, besides the usual voltmeters, ammeters, switches, fuse blocks, etc., includes a series of potential indicators, one for each group of cells ; an electrically operated switch, by means of which the current may be turned on or off the house mains, by pressing push buttons in different parts of the house ; a ground detector for the battery ; a leakage detector for the different lamp circuits ; and finally, and most ingenious of all, a compound relay which controls automatically, by means of varying hydraulic pressures, a powdered carbon resistance, placed in the charging circuit between the dynamo and the battery, which keeps the charging voltage practically constant. The house is supplied with 350 incandescent lamps, varying in candle power from 10 to 50 each, two arc lamps, and three fan motors. Current is also supplied to Mr. Brush's private laboratory. The plant has been in constant operation for the past six years, and it is found after continued use that the amount of attention necessary to keep it in working condition practically amounts to nothing.

An important feature of this experiment is the good behavior of the storage battery. Of the 408 cells in constant daily use, Mr. Brush informs me that not one shows serious signs of failure, and that all are in good, serviceable condition. He has never renewed a plate since the battery was first set up. One could scarcely ask for stronger proof of the ability of storage batteries to meet the requirements of this service.

From a commercial point of view the only criticism to be made in connection with Mr. Brush's plant is the great first cost which the complex construction necessarily involves. However much they may appreciate the convenience and desirability of possessing such a home luxury, there are comparatively few householders that can afford the expense. The question naturally arises, therefore, cannot the same results be secured without the expense?

It was in the effort to answer this question in the affirmative that the writer, some two years ago, undertook a series of experiments which have already yielded such promising practical results that he is encouraged to believe the answer complete.

The three obstacles which, in the past, have stood in the way of commercial success in this particular line of electrical development, viz.: expensive and inefficient windmills, the need of a dynamo especially designed for variable driving speeds, and costly, as well as unreliable, storage batteries,—are no longer formidable.

Since Sir William Thompson first called attention to the subject in 1881, there have been many improvements in windmill construction, all of which have tended to increase its efficiency, while decreasing the cost of manufacture. Steel is taking the place of wood as a material, both in tower and wheel, with less dead weight in the moving parts, and correspondingly greater speed. The power lost through friction is therefore diminished. Another feature is the rapidly increasing number of "geared" mills, manufactured each year; the reciprocating or "pumping" mill not being suited to the work of driving machinery.

The *useful efficiency* of the best types of geared mill now on the market, compares most favorably with that of the best simple steam-engines, when the total amount of energy available in each case is considered, and the difference in first cost is not so great as is popularly supposed. The windmill costs nothing for either fuel or attendance, while the allowance for depreciation is less than half that allowed for the engine.

The following table showing the actual useful horse-power developed by windmills of different sizes, is the result of my own experiments, made with wooden wheels, driving a differentially wound dynamo. It will be found to be a conservative though fairly accurate one, for the best mills of this class. For the best steel mills the figures should be increased 20 per cent.

Diameter of Wheel.	WINDMILL.						
	Actual Useful Horse-power Developed.						
	8-M. Wind.	10-M. Wind.	12-M. Wind.	16-M. Wind.	20-M. Wind.	25-M. Wind.	30-M. Wind.
12-foot Wheel..............	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{2}{3}$	2
14 "	0	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{3}{4}$	$2\frac{1}{2}$	3
16 "	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{1}{2}$	$2\frac{1}{4}$	$3\frac{1}{4}$	4
18 "	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{4}$	2	3	4	5
20 "	$\frac{3}{4}$	$1\frac{1}{4}$	2	3	4	$5\frac{1}{2}$	7
25 "	$1\frac{1}{4}$	$1\frac{3}{4}$	3	$4\frac{1}{2}$	6	8	10
30 "	2	3	4	$5\frac{1}{2}$	7	9	12
35 "	3	4	$5\frac{1}{4}$	$6\frac{3}{4}$	$8\frac{1}{4}$	$10\frac{1}{2}$	14

By "useful horse-power," is meant that actually applied to the shaft of the armature, as shown by the voltmeter and ammeter, allowing 500 watts per horse-power.

Next to the windmill, the most important factor in the problem is the dynamo. The service conditions here are so radically different from any found in ordinary practice, that a special machine is a necessity. The speed is never for a moment constant, and the variations are both sudden and great, with corresponding fluctuations in the current produced.

Heretofore, the effort has been to regulate for changes in speed, by some form of resistance device placed in the field circuit, and operated either by a centrifugal governor or an electro-magnet, the brushes being shifted automatically as the load changed. Such a construction is objectionable for two reasons, viz.—it adds to the number of delicate parts, and hence to the chances of a break-down, and it also greatly increases the cost of manufacture.

I have found that it is possible to secure the most satisfactory regulation by a simple, differential winding of the field. The dynamo is compound wound, with the compound, or series coil reversed. The field is therefore strongest when no current passes through this coil, (*i. e.*, when the line circuit is open) and it becomes weaker as the current out-put increases ; thus reversing the usual practice.

With the proper number of turns of wire in the compound coil, it is possible to operate this machine safely between any given speed limits, but since the regulation must necessarily be secured at the expense of efficiency, it is not wise to make these limits too great. On the score of economy, it is well to so adjust the mill itself that the maximum speed of the dynamo is never more than double the average working speed. With carbon brushes of good size, and a properly designed armature and commutator, there is no necessity for any movement of the rocker arm under the most violent fluctuations of load.

This method of regulation is as effective as it is simple. It is peculiarly well adapted to windmill service since the working or charging circuit must always contain a storage battery, and the resistance of the line is necessarily small. A slight rise in the voltage, therefore, produces a very considerable increase in the regulating current, and hence the lamps are never subjected to extremes of pressure, however much the speed may vary.

The automatic cut-out used between the dynamo and the battery is simple and inexpensive and never fails to do its work. It closes the charging circuit when the voltage of the dynamo equals or exceeds that of the battery, and opens it the instant these conditions are reversed.

The third essential element in our generating plant is the storage battery. Experience shows that a wind velocity of at least six miles per hour is necessary to drive a windmill. Consequently, there are hours, and even days, at a time when it cannot be depended upon to do effective work. The storage supply must therefore be sufficient to tide over such periods of calm.

Where windmills are used to pump water, it is the general practice to have the storage tank large enough to contain from three to five days' supply. The same rule should hold in determining the storage capacity for the electric plant. Much, however, will depend upon the location of the mill. Along the seacoast, or on the prairies of the west, where the wind blows almost constantly, a three days' supply is ample, but in many other parts of the country a full week's reserve may be occasionally needed.

There is a constantly growing demand for small, isolated lighting and power plants, which can be installed at a moderate cost, and cheaply maintained. The demand is naturally greatest in the suburban, and nearby country districts, particularly those surrounding our larger cities, where the luxury of electric light is fully appreciated and would be secured if the expense were not prohibitive.

It is in this field that the windmill, as a source of cheap power, must find its greatest usefulness. It is admirably adapted to the work, and, in the opinion of the writer, such an electric plant will be found to be more economical than any other, where the number of lights supplied is not too great. The cost of operation is practically limited to the two items of depreciation, and interest on money invested, since no attendance, beyond occasional inspection, is necesssary.

A plant which has been in very successful operation at the summer residence of Mr. Geo. E. McQuesten, at Marblehead Neck, Mass., during the past six months, is the best practical illustration of what has recently been accomplished in this line. The experience of Mr. McQuesten is the more valuable, because of the fact that for three summers previously he had used a steam plant to do the same work, and he is therefore in a position to judge impartially as to the relative economy of the two.

The steam plant (including engine, boiler, dynamo, and 46 cells of storage battery) was originally installed at a cost of $1000, and was in operation six months in the year for three years. From data kindly furnished by Mr. McQuesten, I find that the average operating expenses during this time, including cost of fuel, repairs, oil and other supplies, but exclusive of interest charges, depreciation and attendance, amounted to one cent per lamp hour. Depreciation at 10 per cent. would amount to $100, interest at 5 per cent. to $50, and cost of attendance to at least $75 more per annum. The total number of lamps supplied was 75,—60 in the house and 15 in the stable.

The present windmill plant was completed in May last. Mr. McQuesten personally superintended the construction, designing and arranging every detail, and has since taken the greatest interest in its successful operation. The windmill is an "Eclipse mill," with a wooden wheel 20 feet in diameter, mounted upon a substantial tower of wood 75 feet in height. At the foot of the tower and enclosed within the limits of its base, is a neat frame building which contains all the electrical apparatus. The vertical shaft of the mill is geared to a short counter-shaft within this building, and the dynamo is belted directly to the counter-shaft.

The dynamo is rated at 2 K. W. at 1200 revolutions, and is wound for variations of speed between 750 and 1500 revolutions per minute. It is too small for a mill of this size and at times during the summer has been greatly overloaded. A 3 K. W. machine would have been better. The cut-out is contained in a small box near the dynamo. The storage battery consists of 46 Bradbury-Stone cells, connected in series, each cell having a capacity of 200 ampere hours. Ninety volt 16 candle power lamps are used throughout. Near the base of the tower is a small experimental laboratory and machine-shop which contains tools for working in iron and wood, testing instruments, etc., also an electric motor for power purposes, and 12 incandescent lamps run from the battery.

In addition to supplying light to his own residence (60 lamps), his stable (15 lamps), and laboratory (12 lamps), Mr. McQuesten has extended the wires some 200 feet to the home of a relative, where 50 lamps are supplied.

The cost of the plant, complete, including mill and tower, dynamo, cut-out, storage battery, wiring, except house wiring, and the necessary labor and materials, was $1800. During the six months that it has been in operation, it has not once failed to supply all the light needed, and has cost nothing for maintenance, beyond the price of the oil used for lubrication.

Comparing the two plants we have:

Steam plant, supplying 75 lights, original cost, $1000; depreciation—yearly cost—$100; interest, $50; attendance, $75; operating expenses (1 cent per lamp hour), $100 (six months of summer); total yearly cost, $325, or $4.33⅓ per lamp per year.

Windmill plant, supplying 127 lights, original cost, $1800; depreciation, year—(5 per cent. on mill, and 10 per cent. electrical apparatus) $130; interest, $90; attendance (occasional inspection), $20; operating expenses (oil, etc., estimated), $10; total yearly cost, $250, or say $2 per lamp per year.

The above is certainly a remarkable showing in favor of the windmill as a source of power in the generation of electricity for domestic use.

This field is a broad and fertile one. Proper cultivation alone is needed to produce an abundant harvest.

ALUMINUM, THE SUPERABUNDANT METAL.

By Henry Wurtz, Ph. D.

IN this article facts will appear, convincing to rational minds, that aluminum is destined in the near future to enter abundantly into the affairs of men, to reach a production comparable with those of tin and copper, and rapidly to become as cheap as these metals, at least for equal bulk.

So far as we know the solid portions of our planet, more than half is oxygen. This no chemist believes to possess a metallic form. Of silicon, the next element in order of abundance, we cannot say the same, as it undeniably forms many metallic alloys, and may yet be discovered in metallic form. The element next in abundance, aluminum, forms certainly as much as 8 (possibly 10) per cent. of the shell of the earth of the sixteen miles in thickness that we can explore. It is therefore by far the most abundant of the known metals. The chemical history of the formation of the earth's crust shows that aluminum is exceptional in several respects. Though not difficult to dissolve in water by the aid of alkalies, yet natural and even alkaline waters contain none. Hence it does not, like other abundant elements, flow from springs, pass through rivers, and diffuse throughout the ocean. Though abounding in soils, it is not absorbed by plants that grow thereon, proving its insolubility in those plant excretions and products of decay which dissolve other mineral matters. Hence, during the vast erosions, degradation, and sifting of the materials of continents, aluminum has remained in concentrated forms, and in the débris is possibly as abundant as the all-pervading element silicon. The commonest mica, muscovite (potash-mica), is its most abundant ore, containing 20 per cent. of aluminum. Clay contains 21 per cent. ; dehydrated clay, 24½ per cent. ; emery, 31½ per cent. ; corundum, 52½ per cent. ; and bauxite (now the favorite ore), 28 to 31½ per cent. Bauxite was formerly found only in Europe, but recently was discovered in Georgia, Alabama, and Arkansas. It is hydrate of alumina with a little iron oxide and silica. It has to be converted into pure alumina, and therefore has but small advantage over clays, which in time, on a larger scale, will supplant it. But now bauxite is the only important ore.

Davy's discoveries, in 1807–8, of the metals of soda and potash by electrolysis led to efforts by himself and others to get the metal which they knew must be in alumina. It is, however, held so fast in the clutch of oxygen that it was not till 1826 that the first clew was found. Oersted, of Copenhagen (who six years before had made his grand discovery of electro-magnetism, now of such ruling importance in this very field), first produced aluminum chloride, sought for in vain before by others. He at once attempted its decomposition, selecting as his agent amalgam of potassium, Berzelius having then recently isolated barium with this. Oersted failed, for a reason no one could have foreseen. This was because mercury destroys aluminum. In 1828 the German chemist Wöhler repeated this, luckily using potassium itself, and metal aluminum was born at last into the hands of man.

In 1854 the great French chemist, Deville, began experiments on aluminum and produced enough to be made into shapes illustrating its properties. He worked first with potassium, then with sodium, and finally by electrolysis. At this particular time Bunsen, in Germany, was experimenting also by electrolysis. The discovery of electrolytic aluminum lies therefore between these two. Some make the claim for Bunsen, as he had previously obtained magnesium in the same way. Deville exhibited his "silver from clay" (so labeled) at the Paris exhibition of 1855, where it excited great attention and wonder. In the second French exhibition (1867) large ingots appeared, and various wrought products. In America, Castner, in 1886, brought out his sodium process, making aluminum at a cost of 18 cents a pound, which was realized on a large scale in England. We should ere this have had cheap aluminum by sodium but for the amazing advancement of electro-magnetic machinery. This gave birth to the American Cowles process for alloys, and the American Hall and French Heroult processes for rich metal, which now control the aluminum industry.

The physical and chemical qualities of aluminum, commercially pure, containing less than 2 per cent. of iron and silicon, are as follows: Silver-white, with a shade of violet or lavender; when "matted" by an alkali followed by an acid it exhibits a beautiful dead-white surface. It takes a high polish and burnish. Gravity ranges from 2.56 for ingots, to 2.61 for wrought and rolled, and 2.67 to 2.8075 for foil. While a cubic foot averages 163 pounds, one of silver weighs 656 pounds, or four times as much. At present prices of the two—aluminum 70 cents per pound, avoirdupois, and silver 60 cents per ounce, troy—spoons, forks, cups, etc., of silver should cost 12½ times, and with aluminum at 50 cents per pound (as in Europe) 19 times, as much as those of aluminum. It ranks in malleability and ductility almost with gold and silver, and can be drawn into fine wire and tubes, and forged, stamped, pressed and "spun" into all shapes, and beaten as thin as gold, but curiously does not become translucent like leaf-gold. When forged, drawn, or stamped cold, it becomes, like soft iron, hard and rigid, especially when other metals are present, and requires frequent annealing. When perfectly pure it resembles iron, gold, silver, copper, etc., in being too soft for many practical uses, for which it has to be hardened by a little iron, or especially with silicon ; this latter bearing to it the same relation as carbon to iron, conferring steely qualities of hardness and strength. Its electric conductivity is uncertain, but probably about half that of copper, for bulk. For weight, the ratio is 57 for copper to 100 for aluminum. Its heat conduction approaches the same ratio. It resists oxidation, though in time a thin film, readily rubbed off, dulls its luster. It resists saliva and organic liquids ; hence it is adapted for dental plates and surgical uses. For culinary and table-ware it is far better than silver, which is rapidly corroded by sulphur compounds. Alkalies and hydrochloric acid dissolve it rapidly. Mercury, made to enfilm it, causes it to oxidize energetically. Aluminum melts between silver and zinc, the point being uncertain. Thus Mallet says the impure commercial aluminum melts more easily than chemically pure ; while Carnelly states that with 0.5 per cent. of iron it melts about 1290° F., and with 5 per cent. of iron a hundred degrees higher. These statements are hardly reconcilable. It volatilizes in the electric arc, but not in any furnace fire. It is melted in black-lead pots. In clay crucibles it takes up silicon. Fluxes contaminate it, and a covering of charcoal powder suffices. The specific heat is twice that of iron, quadruple that of silver, and nearly seven times that of gold. Hence, though less conductive of heat, it feels far colder than these. The latent heat of liquefaction is undetermined, but large, from the long time required for fusion. Aluminum is remarkably sonorous, ringing like silver.

As to the methods of getting aluminum, only the most prominent in use—two in America and one in Europe—can be explained in the space here available. The Cowles process (American, 1885) produces alloys only, mainly aluminum-bronzes or copper alloys. An arc between very large carbon electrodes is diffused throughout alumina, corundum, or other ore, mixed with granulated copper and carbon. It is in part an adaptation of the first electric furnace of the British patent granted January 31, 1862 (to E. H. C. Monckton), specifying the application of electric currents to "the reduction and fusion of ores and metals that are otherwise intractable, by intensifying the heat of ordinary furnaces, as for example, the reduction of aluminum." The alumina melts, and is deoxidized by the carbon, the aluminum being even converted partly into vapor by the heat of the arc. Such vapor is absorbed by the copper to the amount of 30 per cent. or more. This rich alloy is subsequently melted with more copper to bring the aluminum to the proportion desired. The Hall process (American, filed in 1886), operated by the Pittsburgh Reduction Company, is to employ also at Niagara 6500 electrical horse-power. This company now monopolizes the American trade in pure and "commercially pure" aluminum. The process is the electrolysis of fused cryolite (or other fluorides) kept saturated with pure alumina dissolved at intervals. Fusion is maintained by resistance of the cryolite, which is a poor electrolyte, and can therefore be regulated by more or less alumina, which decreases the resistance. If the fluoride bath be pure, the metal obtained should also be pure; but as native Greenland cryolite is used, for economy, its contaminations, silicon and iron, are introduced. Nevertheless the Pittsburgh company now advertise metal of 99.6 per cent. at special rates; ingots over 98 per cent. for 58 cents per pound by the ton; 60 cents for 100 pounds; and for less, 63 cents. Also 94 per cent. ingots (for siderurgical uses), at 50, 53, and 55 cents respectively. The baths are in cast-iron pots lined with carbon as cathodes, with carbon anodes, which are gradually consumed by the oxygen of the decomposing alumina, and require renewals. If bronze is made, the anodes are copper. The temperature is below that of fusion of copper. The aluminum realized is 94½ per cent. of that added as alumina. Each bath yields one pound of aluminum per hour, with a consumption of 18.1 electrical horse-power hours, and of one pound of carbon anode. The Heroult process (French, 1887), when making pure aluminum, appears practically similar to that of Hall, but without solvent for the alumina fed in, this being kept in fusion by the arc, as in the Cowles apparatus. The carbon anodes of course are consumed. For bronzes, the fused alumina rests upon melted copper, which becomes highly charged with aluminum. It has been operated since 1888 by water-power on a great scale at Neuhausen, Switzerland, at the Falls of the Rhine, by the Industrie Actien-Gesellschaft, who advertise aluminum (grades not stated) for 45 cents per pound. It is operated also at Froges, in France, by water-power.

Well polished aluminum yields in luster and beauty to no other metal, and, exposed to close air with its sulphurous taints, retains polish where silver tarnishes at once. Castings and sheets acquire on a steel-brush wheel a finish equal in beauty to polishing. Smooth surfaces are matted by blackening with potash lye, pickling with sulphuric and nitric acids mixed, washing and drying in sawdust. In burnishing, vaseline is used, also borax solutions. Aluminum foil, rolled to 1/2000 inch, is superseding silver for decoration. The best temperature for working is 400° to 600° F. Aluminum is annealed at red heat with slow cooling. The best tubing has been drawn abroad. Such light, strong, incorrodible, infrangible tubing is of immense importance. In casting, aluminum must not be overheated, as it then occludes gas and forms blowholes. As before stated, Carnelly makes the melting point near 1300° ; Roberts-Austin puts it away down to 1120° F. Aluminum foundry-work is rapidly increasing. Hollow-ware is cast $\frac{1}{16}$ inch thick, which bends almost double without cracking. Molds are best operated by air-pumps with asbestos pistons, both for vacuum and for pressure, by the Smith process. Castings that are thin and sharp, without cavities, result. Soldering is just being learned, and alloys and fluxes too numerous to mention are being tested. Electric welding for wires, rods, and sheets is likely to be preferred. As a flux, silver chloride is claimed to answer even with common soft solder, but something cheaper must be found. Plating cheaper and stronger metals—steel, copper, aluminum-bronze, etc.—with pure aluminum is an open and fertile field. Chasing, embossing, and engraving are matters for the artist rather than the artisan.

The uses for the lower grades of aluminum are as yet comparatively restricted, but will soon absorb, for ornamental uses only, large and increasing amounts. The veneering of non-metallic surfaces and the plating of metallic surfaces will be important also for protective purposes. Here its persistence, resistance to corrosion, color, softness, and pliability are paramount even to its levity. The case of pure aluminum is analogous to that of pure iron, which as yet is little more than a curiosity. For leaf, fine wire, medals, medallions, coinage* (this alone would lead to a very great expansion of pure aluminum manufacture), statuettes, ornamental castings, cards, tickets, baggage-checks, thread for textile fabrics and lace, plane and concave mirrors, picture frames, combs, buttons, book bindings, and generally for all cases in which color and durable luster will tell, the pure metal must come into demand. It will be required also for surgical uses and as a laboratory agent.

Uses of the "commercially pure" metal—say 94 or 95 per cent. —must soon become more numerous. From a feasible mode of coating iron with such metal, as now with tin or zinc, a very important industry would rapidly rise, in which alloys would also be employed. The principal uses for these grades are now for making alloys and as an addition to molten steel and iron. Whatever is to come hereafter, the largest field for aluminum now is in the form of alloys. An arrangement of these, somewhat in the order of their importance, is thus: alloys with copper (bronzes); copper and zinc (brasses); iron and steel; zinc (for "galvanizing"); lead and antimony (type-metals); manganese; silver; nickel; tin. Others are under investigation. One tenth of the make of the Pittsburgh company in 1893 was sold for making bronzes, being equivalent to 340 tons of bronze of medium grade, and another tenth for alloying with brasses. These bronzes contain from about 2½ to 9½ per cent. of aluminum; the most valuable being a definite compound with 9.36 per cent. aluminum, of a pale "jewelers' gold" color, and gravity 7.534. Another, containing 5 per cent., has so nearly the color of fine gold that experts are deceived. An intermediate compound containing 7.85 per cent. has the color of green gold. These colors rival gold in permanency in the air and slowness of tarnish. The strength of these bronzes equals that of good steel. Cowles's "A1" bronze, made from corundum, tests from 95,000 to 128,000 pounds per square inch, averaging 111,280 pounds. Heroult-process bronzes have stood from 50,000 to 90,000 pounds. Heat has little action on them,—not even a red heat for months. Agents which soil their surfaces, as perspiration, etc., go no deeper. Ductile in the cold, they can be forged at a red heat like iron, and stamped, pressed, and spun into all shapes. Their rigidity is twice to thrice that of ordinary bronze. One drawback is shrinking in the mold when cast, but this is overcome by yielding and plastic cores. As with common bronzes, two or three remeltings are needed to impart the best qualities. Unlike steel, they are softened by chilling. In electric conduction they are close to copper, from which are apparent enormous prospective uses. Alloys with nickel possess a rigidity equal to that of the best steel. Of these the writer has a sample that has stood such tests. Aluminum brasses, like the bronzes, are far stronger, more ductile, less corrodible, and of finer colors than common brasses. Brass with but 4 per cent. of aluminum has stood a strain of 98,000 pounds per inch. In durability under action of heat, however, they are far below the bronzes.

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* This is an application which, for "token" coins, should be adopted by all nations, now that the supply of aluminum has become but a question of demand. Professor Richards, in his second edition (p. 370), condemns the use for coins on very remarkable grounds, one being that a coined metal should have a "value as nearly fixed as possible." To mere tokens, this is totally inapplicable. What is needed for these is exactly such a metal as aluminum. Richards refers to experiments of the United States government in 1865 on aluminum coinage, and surmises that the "results were not sufficiently successful." He is in error here. They were in the highest degree successful. The then secretary of the treasury, Mr. Chase, intended to recommend favorably to congress half-dime coinage of aluminum, but when he was appointed to the supreme bench the project fell through. John Torrey, then United States assayer in New York, brought the subject before the government. Dr. Torrey and the officers of the United States mint were highly pleased with the coins—which were at least equal in beauty, if not superior, to the aluminum medallions, or "Chicago memorials," so abundantly distributed at the late World's Fair. The writer, with whom the project originated, built sodium-furnaces, made sodium, and was building aluminum-furnaces, guaranteeing to supply enough metal, without which Secretary Chase would not have moved in the matter. It is stated that samples of these coins and medals from Dr. Torrey, are now contained in the Lenox library collection, in New York. H. W.

There are no more striking and extraordinary characteristics of aluminum and its alloys than their influences over iron and steel. Metallurgists now admit that if aluminum had no other use, its value in the annihilation of blowholes in casting would make it inestimable. It is found also to soften and toughen iron castings by transmuting combined carbon into graphite. The explanation is yet in controversy. About 20 per cent. of the Pittsburgh company's make of 1893 (some 70,000 pounds) went to steel melters, with 5 per cent. more to iron founders. As the average per ton of steel is 7 ounces, some 160,000 tons of steel castings were thus made strong and safe in 1893. This is not all; the casting of nearly carbonless iron has been almost impracticable because of the monstrous heats required and the number of blowholes in the product. Aluminum added to such iron, in pasty fusion only, instantly liquefies it, and the casting is totally free from cavities. These are "Mitis castings," known since 1885. These discoveries are revolutionizing the arts of siderurgy.

The future of aluminum should receive some attention. A few statistics—available as yet for but six years—furnish a minimum conception of what is to come. Estimates by the Pittsburgh Reduction Company of American aluminum production from 1888 inclusive, are:

In 1888...........................	19,000	pounds.
In 1889...........................	47,468	pounds.
In 1890...........................	61,281	pounds.
In 1891...........................	150,000	pounds.
In 1892...........................	259,885	pounds.
In 1893...........................	342,705	pounds.
In 1894 ... .(estimated)	642,705	pounds.

This 86 per cent. ratio will doubtless increase, but at this rate only the production for successive years will be as follows:

Year.	Pounds.	Year.	Pounds.
1895....................	1,185,622	1900....................	26,394,359
1896....................	2,205,257	1901..................	49,093,508
1897....................	4,101,778	1902..................	91,313,925
1898....................	7,269,307	1903..................	169,843,900
1899....................	14,190,511	1904..................	315,909,654

Thus, ten years ahead, with what may be called the juvenile ratio of growth, we may see in 1904 158,000 short tons. Our United States copper production in 1893 was but 161,000 short tons. At present minimum prices, 45 cents per pound, the value of the product in 1904 should be $142,200,000; but none will imagine that this price can hold until then. Ten cents per pound is more probable. This will be near $31,590,000 for the whole make, and no doubt will leave margin enough for the manufacturers and a modest competence for each inventor besides. A reduction has been publicly promised here as soon as consumption justifies it; and the French manufacturers at Froges promise that when sales reach 3000 tons per annum they can sell aluminum at 15 cents per pound,—equivalent for bulk to about 4½ cents for copper, inherently a less valuable metal.

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An A A	Annals of Am. Academy of Political and Social Science. *b-m*. $6. Philadelphia.
A An	American Analyst. *f*. $1. New York.
A & B	Architecture and Building. *w*. $6. N. Y.
A B D	Arch. Build. and Dec. *m*. $2. Minneapolis.
A C J	Am. Chem. Journal. *b-m*. $4. Baltimore.
A E C U	Asso. of Eng. of Cornell Univ. 1894. Ithaca.
A E R J	Am. Eng. and Railroad Journal. *m*. $3. N.Y.
A G	Am. Geologist. *m*. $3.50. Minneapolis.
A G L J	Am. Gas Light Journal. *w*. $3. New York.
A J P	Am. Jour. of Politics. *m*. $3. New York.
A J R A	Jour. R'y. Appliances. *m*. $2. New York.
A J S	Am. Jour. of Science. *m*. $6. New Haven.
A L	The Architect. *w*. 26*s*. London.
A M	American Machinist. *w*. $3. New York.
A M & I W	Am. Man. and Iron World. $4. Pittsburg.
A M S	Aust. Mining Standard. *w*. 30*s*. Sydney.
A R	Architectural Record. *q*. $1. New York.
A Rev	Architectural Review. *s-q*. $5. Boston.
A S	Age of Steel. *w*. $3. St. Louis.
A S I E	An. of Amer. Soc. of Irri. Eng. 1892–93.
A S M E	Am. Soc. of Mec. Eng. *m*. New York.
B	The Builder. *w*. 26*s*. London.
B A	The British Architect. *w*. 23*s*. 8*d*. London.
B B	Brick Builder. *m*. $2.50. Boston.
B I S	Bul. Am. Iron and St. Asso. *w*. $4. Phila.
B J C	Boston Jour. of Commerce. *w*. $3. Boston.
B M	Banker's Mag. *m*. 18*s*. London,
B T J	Board of Trade Journal. *m*. 6*s*. London.
B U W	Bul. of the Univ. of Wisconsin.
C A	Calif. Architect. *m*. $3. San Francisco.
Can A	Canadian Architect. *m*. $2. Toronto.
C & B	Carpentry and Building. *m*. $1. New York.
C E	Colliery Engineer. *m*. $2. Scranton, Pa.
C Eng	Canadian Engineer. *m*. $1. Montreal.
C G	Colliery Guardian. *w*. 27*s*. 6*d*. London.
Ch	Chautauquan. *m*. $2. Meadville, Pa.
C M	Century Magazine. *m*. $4. New York.
C M R	Canadian Mining Rev. *m*. $1.50. Ottawa.
Cos	Cosmopolitan. *m*. $1.50. New York
C R	Contemporary Review. *m*. $4.50. London.
C T J	Chem. Trade Jour. *w*. 12*s*. 6*d*. Manchester.
D E	Domestic Engineering. *m*. $2. Chicago.
E	Engineering. *w*. 36*s*. London.
E A	Electrical Age. *w*. $3. New York
E A S	Eng. Asso of the South. *m*. $3. Nashville.
E E	Electrical Engineering. *m*. $1. Chicago.
E E L	Electrical Engineer. *w*. 19*s*. 6*d*. London.
E E N Y	Electrical Engineer. *w*. $3. New York.
E G	Engineers' Gazette. *m*. 8*s*. London.

E I.......Electrical Industries. *m.* $1. Chicago.
E L.......Electricity. *w.* 7*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
E M......Engineering Mechanics. *m.* $2. Phila.
E Mag...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N......Engineering News. *w.* $5. New York.
Eng......Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36*s.* London.
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E P......Electrical Plant. *m.* 6*s.* London.
E R......Engineering Record. *w.* $5. New York.
E Rev....Engineering Review. *m.* 7*s.* London.
E R L ....Electrical Review. *w.* 21*s.* 8*d.* London.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W.Pa. *m.* $7. Pittsburg.
E W......Electrical World. *w.* $3. New York.
F ....Forum. *m.* $3. New York.
F D......The Foundry. *m.* $1. Detroit.
F R......Fortnightly Review. *m.* $4.50. London.
F W......Fire and Water. *w.* $3. New York.
F'y......Fairplay. *w.* 32*s.* 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G & F....Garden and Forest. *w.* $4. New York.
G M.....The Geol. Mag. *m.* 18s. London.
G R......Good Roads. *m.* $1. New York.
G W......Gas World. *w.* 13*s.* London.
H & V...Heating and Ventilation. *m.* $1. N. Y.
I A......Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s.* Lond
I C B.....Carpenter and Builder. *w.* 8*s.* 8*d.* London.
IC T......Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I E........Indian Engineering. *w.* 18 Rs. Calcutta.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv......Invention. *w.* 11*s.* London.
Ir Age..Iron Age. *w.* $4.50. New York.
Irm......The Ironmonger. *w.* 10*s.* London.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L....Journal of Gas Lighting. *w.* London.
J M W A.Jour. of United Metal Workers of America. *w.* $1. N. Y.
J N E W.Jour.N.E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
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M........Machinery. *m.* 9*s.* London.
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R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7*s.* London.
R R......Railway Review. *w.* $2. Chicago.
R W.....Railway World. *m.* 5*s.* London.
Ry T.. ..The Railway Times. £1. 5*s.* London.
S... .....Stone. *m.* $2. Chicago.
S A......Southern Architect. *m.* $2. Atlanta.
San......Sanitarian. *m.* $4. Brooklyn.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col.
Sea......Seaboard. *w.* $2. New York.
S In......Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L......Steamship. *m* Leith, Scotland.
S M.....ScientificMachinist.*s-m.*$1.50. Cleveland,O.
S M Q....School of Mines Quarterly. $2. N. Y.
S R......Sanitary Record. *m.* 10*s.* London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P......Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V......Safety Valve. *m.* $1. New York.
T ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
Tr.......Transport. *w.* £1. 5*s.* London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E......Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

Housing of the Poorer Working Classes.

THE much mooted problem of designing and supplying houses to the poorer working classes (such that, while in points of luxury and elegance a good deal inferior to those that can be afforded by people of moderate means, shall yet be much more than mere hovels, and shall at least supply conditions not tending to invite, foster, and spread disease, and which will enable occupants to live in reasonably good health and cleanliness) is still a fruitful theme of discussion at nearly every meeting of architects or engineers where general sanitation is debated. At the recent meeting of "The Sanitary Congress at Liverpool," (under which title *The Builder*, London, and other English architectural publications are serially publishing notices of the proceedings) this subject came up, three papers were read upon it, and a lengthy discussion followed. What was said in the papers and in the discussion does not seem to help much toward a final solution of the question. The poorer working classes were defined by one gentleman who took part in the discussion as comprising those whose income does not exceed one pound a week. He took the ground also that poor people cannot afford more than one-fifth of their earnings for rent. Taking this as a basis, it will be seen that the problem reduces to the construction of clean, healthy buildings that can be rented at about a dollar a week (U. S. money), and which, at this rate, will return the interest on capital invested. Taking into account repairs and taxes, in order to effect such a return this rental must represent about 10 per cent. per annum of the total investment for both the building and its site, which brings the total investment down to $520 for each such dwelling. In populous cities where land is very dear, after the purchase money for site has been deducted, not a very large sum would be left for building.

The facts brought out in the discussion were quite the reverse of hopeful. The status of the question was well presented in the remarks of Sir F. S. Powell who in opening the discussion declared that the paper read had dealt more with minute technicalities than with the general features of the question, but that what had been said made it clear that the results of the experiments so far made were not encouraging. He hit the nail exactly on the head, by saying that "the cost of providing dwellings in which the poorest of our people could live in decency, not to say in comfort, was too high for their wages." The logical conclusion from this is that if the working poor are to be enabled to live even decently, it must be done through charitable aid, unless their wages can be raised. Only better wages can prevent this class from ultimately merging into the pauper class, if they are to live on any higher plane than animals. The pauper class is already too large, and the fact that it is so indicates a failure in some part of the social scheme. If the widely accepted economic principle that wage earnings tend constantly toward the point of bare subsistence be taken into account, it follows that the poorer working class must continually increase; and the difficulty in planning houses to enable them to live in decency will increase rather than diminish. Ergo, unless wages are to be raised it is useless for architects or sanitary congresses to bother their heads any more with the subject.

Dr. Sykes (Medical Officer of Health of St. Pancras) referred to the aspect of this perplexing question in London, where half a dozen large companies were engaged in trying to solve it. The experience was the same. "The large blocks did not pay 3 per cent., and the London County Council had been obliged to increase the price of their dwellings because they could not pay the 3¼ per cent. interest on the money laid out. In London no one would venture to fix so low a rent as 1s. a room. The question was more than a question of cost of land, it was a question of the amount of accommodation to be given. Were four rooms necessary? By means of what Mr. Blashill had felicitously called associated houses was it not possible to reduce the necessary accommodation to one room? Under present conditions three rooms was the minimum number in London. They must have a living room, one or more bedrooms, a scullery and washhouse. The minimum at 2s. 6d. a room would be 7s. 6d. per week. If Liverpool could not make these houses pay, how much less hope was there of London doing so?

Mr. H. Collins (District Surveyor, City of London), who said he had special experience of this class of buildings, thought that in Liverpool there must be gross mismanagement somewhere. He could point to a large number of such buildings paying four or five per cent. interest. He was the architect of blocks of buildings in Canonbury and Deptford which paid from six to seven per cent. "The return was a matter that depended entirely on the management. In a block of buildings in which three families resided, if a child of any of them damaged a brick, the whole of the families were warned that if it recurred they would all have to go. The warning was generally sufficient." Mr. Vigors of the Peabody Fund, had gone into an elaborate investigation to ascertain the lowest rent which could be demanded, and he found that it was 10½d. per room. A client of his was about to invest 30,000 or 40,000 pounds under his direction in such property, not from philanthrophic motives, but for investment. On the Rothschild property the dividend paid was 4 per cent., at Waterloo, 4 per cent., East London, 4 per cent.

Dr. Sykes—Out of capital?

Mr. Collins—The Rothschilds are not the kind of people to pay dividends out of capital.

Mr. C. S. Pain (Liverpool) protested against the heretical opinions he had heard broached in the Congress under the ægis of the Sanitary Institute, He had just heard philanthropy spoken of as discreditable. "One sapient president had suggested a return to back-to-back houses; another sanitarian advocated that abomination the slop-closet; and now all were to live in one room. Was it not time for the Sanitary Institute to disclaim such unsanitary teachings as these?"

It will be seen that there was plenty of disagreement; the only proposition upon which no dissenting voice was raised was the general one that "something must be done." This proposition has so long been accepted that there does not seem much benefit in repeating it, yet the fact that it was the outcome of the debate at the congress seems to indicate the desperate character of the problem of housing the very poor in large cities. May it not be that the difficulties of this problem arise from an imperfect statement of its terms? Why should there be an increasing number of the very poor congregating in large cities to be housed? Is urban life better adapted to the condition of abject poverty than rural life? If dwellings were erected on cheaper land away from cities, could not the class whose near approach to pauperism and crime is regarded as a public danger keep themselves better housed, better fed, and in a better sanitary condition than is possible in a populous town where ground rent must absorb so much of the little they can earn? Why is it that they can earn only so little? These questions first satisfactorily answered, it would perhaps be easier to solve the problem of housing the very poor.

Testing Building Stone.

A PAPER read by F. Lynwood Garrison, Assoc. M. Am. Soc. C. E., at the annual convention of the American Society of Civil Engineers, has such an important bearing upon all architectural and engineering work in which stone is employed, that perceiving this, it has been reprinted during the current month by several publications more or less representative of engineering and architecture. It contains information upon the structural peculiarities of stone, and its fitness for use as constructive material, that every engineer and architect ought to know, but of which it is safe to say, many practicing these professions have very little knowledge.

After its perusal many who have relied upon hitherto used methods of testing stone for ascertaining its fitness for building, will acquire and retain a salutary skepticism of the indiscriminate value of such tests, and will be more cautious in founding final judgments upon them. It is asserted that "at least an elementary knowledge of mineralogy, the study of which has unfortunately not been included in the training of most civil engineers and architects, is needed in order to be able to arrive at correct conclusions as to the value of different kinds of stone for building purposes." The fact is emphasized that "all stones or rocks are compounded bodies, often exceedingly complex, composed of aggregations of various mineral substances whose individual nature and their respective influence upon one another should be understood as far as is possible to arrive at a proper appreciation of the whole." A notable point is the advocacy of the use of the microscope, in the examination of stone, rather than entire reliance upon methods hitherto more commonly employed, though the latter are by no means excluded. These are gone over in detail, pointing out wherein they are liable to error through want of proper skill or care in applying them. In discussing these latter points, the following topics are treated: Form of specimens; cushions; bed or natural position; transverse strength; elasticity; porosity; action of frost; specific gravity; hardness; destructive agents; chemical tests and seasoning. A note is appended upon the bibliography of the subject, in which important literature of the subject is named, together with some that only indirectly bears upon the subject. Mr. Lynwood does not claim completeness for this list of publications, stating that there are a number of German publications which were inaccessible to him.

"The practical value of microscopical examinations of stone is much greater than that of ordinary metallurgical productions. In the one case we have a natural production about which we can do nothing without an investigation. In the other case we have an artificial material made for a distinct and definite purpose, to effect which we must needs know more or less of the characteristics and relative reactions of the individual elements constituting the desired compound.

"The tests ordinarily applied to building stone, to determine its physical properties, although few in number, are in some instances rather complicated and often unreliable. The first and most essential is to determine the structure and character of a stone, to know whether it be granite, sandstone, quartzite, or something else. Although an expert can usually determine at a glance to which, if any, of these groups a particular stone belongs, it is frequently possible to determine the precise lithological character only by a microscopical examination. Thus, for instance, there is a class of Cambrian rocks commonly called sandstones (Potsdam ?) that are not sandstones at all, but are hard, compact rocks known as quartzites, which have been derived from sandstones by metamorphic action. The essential difference between a sandstone and a quartzite lies in the presence of secondary silica between the quartz granules comprising the latter; the presence of this secondary silica or quartz can be determined for a certainty only by microscopical means. The microscope is not only useful in determining the structure of a stone, but it has an even greater practical value in making it possible to detect the presence of deleterious substances such as pyrite, and marcasite (iron sulphides) or other minerals whose chemical composition is affected by atmospheric agencies and thus exert a deleterious effect upon the stone. The application of the microscope to this, as to every purpose, requires some skill and training, which may, however, be readily acquired by any one to whom the subject is of sufficient interest, microlithology being thoroughly treated in standard works available to all." Microscopical study should be pursued under the guidance of a competent teacher, books on microlithology hardly being competent to take the place of a living instructor.

Competitive Plans.

WITH reference to the system of competitive plans, as now practiced, architectural publications have said a good deal of late by way of protest against it; but interest in the subject will continue so long as the abuses of the system are felt as they now are. One argument in favor of the system is that beginners in the profession sometimes are able thus to obtain work which otherwise they have little chance to obtain. But there is little doubt in the minds of thoughtful men that a better system could be evolved, which while it would obviate the annoying waste of time and effort that now obtain, would not increase disadvantages which young men in all professions encounter before they are able to gain a reputation that in itself brings business. Under the title, "The Pernicious Practice in Selecting Competitive Plans," *The Southern Architect* in its October number attacks the present system vigorously and promises to conclude what it has to say in its November number. In lieu of the system now in vogue, a method favored by many is advocated.

"How much better would open competition be at all times to a limited number of the profession, with remuneration to cover actual expense entailed, without concealment of names, and designs to stand on their own merit as to beauty, utility, economy, symmetry, and cost as decided by an expert appointed to act with a committee! And after the award has been made to hang the designs for public inspection, it must be admitted that the present system produces an effect the very reverse of what is intended, and often ends in a disgusting quarrel, newspaper controversies, and shameful reflections on many concerned. If the merchant can sell his rejected goods for something to the public, the architect cannot sell his designs (no one building would ever suit the exigencies of locality and of new surroundings); although plans have cost months of slavery, office and traveling expenses, they will fetch nothing. They may be the grandest conception of good taste, yet they are useless."

There can be but little doubt as to the immediate salutary effect of such a method as it is here proposed, and it would be very desirable to have it extended to all competitions in the building trades as well.

Woman in Architecture.

THE graduation of a young woman from the Maryland Institute who, it is asserted, intends to adopt architecture as a profession, and the announcement that the Cooper Institute (New York) trustees intend to establish classes in architecture for women, have called forth expressions both of approval and disapproval from our contemporaries. *Architecture and Building* (Oct. 6) looks upon this project as one that promises much for women, if not for the advancement of the art. Perhaps it is rather early in the day to give so positive an opinion as some express upon this subject. Women have not yet had a fair chance to show what they can or cannot do in a profession from which, until the present generation, they have been excluded. Adverse views were held by male practitioners in law and medicine when it was first proposed to admit women to the practice of these professions, yet women have passed excellent graduating examinations in both, and some have risen to eminence in them. There is, therefore, pretty good ground for believing that, once admitted, they will make their way in architecture, particularly in some branches of the art. Of this innovation it is said editorially that "if nothing else," it "seems to indicate a change in sentiment as to the propriety of the sex entering on such callings as well as her ability to do so. What has already been accomplished by women in art and in many branches of the arts of design indicate an ability to cope with architectural design with the same readiness as her brother, and in the draughting room there can be little doubt that she will prove an average equal. In fact, for this class of work, she has every requisite for success. Her taste will more than average with man's; her perception is keen, and with that intuitive knowledge and quickness of expression which is her characteristic in every-day life, she is likely to prove a formidable rival to her slower-growing and less keen-witted brother in some branches of architectural work."

But it it also urged that the instincts of women will inevitably direct them to "specialties in any such profession as architecture and that no woman is likely to be long the director of the constructive work of a building. She would soon conclude her sphere of usefulness lay in other directions. Not that she could not as fully comprehend and direct as a man, but she would soon tire of its disagreeable features." In this most people will probably agree with this very temperate, fair and unprejudiced view of the subject. It is hoped that women may have their chance in architecture, and opportunities to make the most of it.

American Theaters.

THE literature of theater construction and design has not recently lacked contributions. Both in American and English publications the subject has received, and is now receiving, an unusual amount of attention. For the most part, it has been treated in serial papers, and most of the important theaters and opera houses in the large cities of the world have been illustrated with exterior and interior views, or will have been, when a series of papers entitled "The Planning and Construction of American Theaters," commenced in *Architecture and Building* in its issue of October 13, and written by Mr. Wm. H. Birkmire, shall be completed.

A commencement is made with a description of what is probably the largest building in the world devoted wholly to popular amusement, Madison Square Garden, occupying the entire city block bounded by Fourth avenue, 26th street, Madison avenue (on which is the main entrance) and Twenty-seventh street, in New York city. An excellent illustration of this building (which, though only completed last year, is becoming famous not only for its great size but for the beauty of its architecture) is given, and it is to be regretted that the brief description of the building could not have been aided by interior views, which, however, are wanting. As it is, while the beauty of the exterior and the great size of the structure are well indicated, a very imperfect conception of the interior can be gained.

A description is given of the Metropolitan Opera House, New York, which having been seriously injured by fire has been recently remodeled. Neither exterior or interior views of this theater are supplied. The lighting of the great building requires 10,000 electric lamps, and nearly half of this number are on the stage. With the description of the famous Chicago Auditorium, two interior views are given. It is evident, from all the descriptions that brevity has been studied. The stage of the Auditorium has some special features.

"The dimensions of the stage are 70 by 110 feet. The height from the floor to the rigging loft is 95 feet. The stage floor is divided into sections, all of which are separately or jointly movable in the vertical plane. This movement is effected by twenty hydraulic jacks, the plungers of which range from 6 to 24 inches in diameter and which are operated under a pressure of 100 pounds per square inch. The valves controlling these jacks are concentrated in such a manner that a person operating them is always in a communication with and under control of the stage manager. It is possible with this apparatus to create variations and gradations of level of stage floor almost instantaneously in any direction, up or down or oblique, for any part of the stage floor. This hydraulic apparatus is modeled upon that patented by the 'Asphalia' of Vienna, and applied by it in the opera house of Buda-Pesth, Prague and Halle. The ingenuity of American builders of hydraulic elevators and the special conditions prevailing in this building have, however, caused the introduction of many improvements and modifications of the European apparatus.

Yet the main room in this building is too large for any successful dramatic presentation. The actors cannot be well heard in so large a room. Operas and concerts may be well rendered in it.

After this brief trip to Chicago a return to New York is made, and after brief mention of the Empire Theater follows a partial description of the Abbey Theater, but which, more elaborate than the previous ones, and is to be continued. While not very comprehensive, these descriptions, so far as they go, will serve to give fairly good general ideas of most of the theaters selected as subjects.

Dwellings for the Poor in Edinburgh.

MORE light upon the subject of city dwellings which can be let at low rentals, may be derived from an abstract of a report of a sub-committee of the Lord Provost's committee of the Edinburgh Town Council, which deals with the subject of dwellings for the poor, and which is printed under the above title in the *Architect* (London). The idea is to build one block of 56 houses, if such buildings ought to be called houses, 24 of one room, and 32 of two rooms each. The lowest rentals in the city are $50 a year. In the words of the committee, " Edinburgh suffers severely from want of sanitary and healthy housing for its poor and laboring classes." From which it may be inferred that there are many poor families in this famous old Scotch city whose wage earnings will not permit them to pay as high as $50 per year rent for their homes.

" It is sometimes argued that this matter may be left to private enterprise, but the sub-committee are unable to detect any likelihood of private enterprise doing anything in the matter. Past experience proves that private enterprise will not be by any means forward in taking up this question. Private philanthropy has done more perhaps for Edinburgh than any other city in the kingdom, but no such agency, other than the Social Union, has as yet come to the front. The sub-committee is convinced, after a careful consideration of all the circumstances of the case that the public authorities themselves must face this question in a practical way; and they further consider that, if properly conceived and carried out, with the aid of the facilities provided in favorable borrowing powers, such an undertaking may be financially self-supporting, besides resulting in social and moral benefit to the inhabitants of the districts in question, and therefore to the whole city."

It is asserted that in this experiment the best features of modern improved housing for the laboring classes will be adopted, that is to say, the scheme will aim at providing . . . . houses which will to a large extent combine advantages of home privacy, the convenience and supervision of a modern lodging house with all modern sanitary appliances, a recreation hall, a creche, children's grounds and other advantages. In order that the rentals shall pay a moderate interest on the investment, the rentals will be for each of the 1-room apartments £5 4s., and for the 2-room apartments £7 6s. per annum.

This seems to indicate a belief, surely not warranted by the previous history of similar attempts, that the erection of such tenements will abolish slum life in Edinburgh, which of course depends more or less upon what is meant by slum life. A very large part of the slum life in New York city is to be found in tenement houses very like what are to be built in Edinburgh, barring the recreation hall the creche, children's grounds, etc., which would admittedly be an advance upon ordinary tenement house conditions.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25759. Historical Architecture in Current Use.—A Striking Arraignment of Present Methods. William Henry Goodyear (E Mag–Dec.) 4500 w.

25797. Old and New Buildings of New York. Ill. (Sc A–Oct. 13.) 500 w.

*25861. Whitby Abbey (B–Oct. 6.) 1800 w.

*25809. Fireproofing City Houses. C. H. Blackall (B B–Sept.) 1400 w.

*25894. Machinery for Building (I C B–Oct. 5.) 1600 w.

*25976. A Temple of the Tokugawa at Nikko. Ill. C. T. Matthews (A R–Oct.-Dec.) 4500 w.

We supply copies of these articles. See introductory.

*25905. Frieze and Cornice. W. N. B. (Pl D-Oct.) 1200 w.

*25977. Influence of the French School on Architecture in the United States. Ill. Ernest Flagg (A R-Oct.-Dec.) 4200 w.

*25978. The University of Chicago. Ill. Charles E. Jenkins (A R-Oct.-Dec.) 1600 w.

*25979. Architectural Aberrations.—College of St. Francis Xavier (A R-Oct.-Dec) 1500 w.

25988. Acoustic Properties and Resonance of Buildings (Sc A-Oct. 20.) 1000 w.

26041. Woman in Architecture. Editorial (A & B-Oct. 6.) 900 w.

*26098. Dwellings for the Poor in Edinburgh (A L-Oct. 5.) 1400 w.

*26099. The Housing of the Working Classes; Sanitary Powers Relating Thereto in Liverpool. (Abstract.) W. Goldstraw (A L-Oct. 5.) 3200 w.

26123. Report of the Committee on Education to the American Institute of Architects. Henry Van Brunt, Chairman (A A-Oct. 20.) 2800 w.

26124. Skeleton Construction and the Fire Department. T. M. Clark (A A-Oct. 20.) 2000 w.

*26136. Foundations in Deep and Unreliable Soils. Address of Charles Baillairgé (Can A-Oct.) 4000 w.

*26137. Notes on Some Aspects of the City of the Future. A. T. Taylor (Can A-Oct.) 1700 w.

*26144. The External Color Decoration of Buildings. Cesare T. G. Formilli (A L-Oct. 12.) 2700 w.

*26217. Progress of the Wembley Tower. Ill. (I & I-Oct. 19.) 1500 w.

†26230. Notes on the Hardening of Mortar. William P. Mason (J A C S-Nov.) 400 w.

*26243. Regulations for the Preservation of Ancient Buildings in Italy. Translated by John Hebb (A L-Oct. 19.) 1600 w.

*26244. Discoveries in Architecture. T. Roger Smith (A L-Oct. 19) 5500 w.

*26245. The Style Hunters. J. W. Yost (A L-Oct. 19.) 1800 w.

*26283. The History of Architecture. Ill. J. Edwin Forbes (I C B-Oct. 19.) 7000 w.

26300. Italian Villas.—From N. Y. Tribune (A A-Oct. 27.) 2000 w.

†26330. The Churches of Provence. Ill. Mrs. Schuyler Van Rensselaer (C M-Nov.) 10000 w.

*26362. On the Use of Brick in Ecclesiastical Architecture. Ralph Adams Cram (B B-Oct.) 2200 w.

*26447. Tiles. (I C B-Oct. 26.) 1200 w.

26477. The Wholesale Architect as an Educator. C. H. Blackall (A A-Nov. 3.) 2000 w.

*26485. Workmen's Dwellings in Manchester and Salford (B A-Oct. 26.) 2500 w.

*26542. Greek Sculpture in Relief (A L-Oct. 26.) 3700 w.

26589. Reasons and Remedies for Rust in Skeleton Structures. Clement D. Rinald (A & B-Nov. 10.) 2800 w.

26610. Concrete Construction.—Its Practical Application. Ernest L. Ransome (Sc A S-Nov. 10.) 4800 w.

26623—75 cts.. The Selection of Sites for Federal Buildings. Glenn Brown (A Rev-Vol. III, No. 4.) 2000 w.

26624.—75 cts. Architectural Education for America. Albert L. Brockway (A Rev-Vol. III, No. 4.) 3600 w.

Serials.

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6, 1893—35 parts to date—15 cts. each).

18857. Electrical Science for Architects. Russell Robb (A A-Began Jan. 13—7 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. Ed. W. Hind (S-Began Jan.—8 parts to date—30 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. (B B-Began Jan.—10 parts to date—30 cts. each).

20419—Modern Methods of House Painting. A. Ashmun Kelly (Pl D-Began March—8 parts to date—30 cts. each).

21288. Theatres. Ill. (A A-Began April 14—7 parts to date—15 cts. each).

21618. Bay Windows and Oriels. Ill. F. Jerman (I C B-Began April 20—11 parts to date—30 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B-Began April—6 parts to date—30 cts. each).

22717. Terra Cotta in Skeleton Construction. D. Everett Waid (B B-Began May—3 parts to date—30 cts. each).

24273. Arkansas Marbles. T. C. Hopkins (S-Began Aug.—3 parts to date—30 cts. each).

25577. The Influence of the Hanseatic League on the Architecture of Northern Europe. Ill. J. Tavenor Perry (A A-Began Sept. 29—3 parts to date—15 cts. each).

25843. The Pernicious Practice in Selecting Competitive Plans (S A-Began Oct.—1 part to date—30 cts).

26069. Modern Steel Fireproof Construction. F. M. Small (A & B-Began Oct. 13—1 part to date—15 cts).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (A & B-Began Oct. 13—1 part to date—15 cts).

26135. Artificial Foliage in Architecture. Ill. Hugh Stannus (J S A-Began Oct. 12—3 parts to date—30 cts. each).

26202. Theatre Fire Catastrophes and Their Prevention. Ill. William Paul Gerhard (Sc A S-Began Oct. 27—2 parts to date—15 cts. each).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Construction of Irrigation Canals.

As an aid to "irrigation engineers who are only beginning their experience in that line," Mr. H. P. Bell has contributed to the *Annual of the American Society of Irrigation Engineers* for 1892–93, issued in October, a paper entitled "Random notes on the survey and construction of Irrigation Canals," which is an important contribution to the literature of irrigation. At the outset he confesses that there was a time when these notes would have been of good service to him, and hopes they may be of similar service to others.

Upon the subject of surveys many useful hints are given. "The first operation is to begin at the selected head and take a series of long sight levels down the course of the river to ascertain its approximate fall." A case is cited (of a large river) where the result of this necessary work proved that no canal was possible within the limits of the district to be benefited, the fall being insufficient. Suppose the fall is to be within limits of practicability. "It is seldom necessary to go further than a certain distance to obtain the necessary information. Perhaps one-fourth to one-half the length of the projected canal. These levels should be taken with two rods to save time, the engineer making a sketch and estimating roughly his distance at the same time."

The survey, after the engineer has gone down the river far enough to satisfactorily determine its fall, is to be extended "hillwards across the valley until he records the elevation assumed as the head of the works," and until he is able to "fix the location of any chosen grade upon the line of his cross levels according to his estimated distance, and is therefore also in position to estimate approximately the rate of his grade."

Next a turn at right angles from the "hillwards" line of survey is advised and a leveling down the valley "more or less upon the line of the canal, still guessing the distance, and going up or down if he thinks it worth while, or necessary to rectify position from time to time, according to the distance estimated and the grade assumed.

A method used by "the select few" but which is alleged to be simpler than the prevailing method is noted.

"An expert engineer and two good rodmen (they may be laborers) will find no difficulty on moderately even ground in making good more distance throughout the day than he will care about covering again if he has to walk home at night. Having gone as far as it is intended to build the canal he should turn at right angles across the valley back to the river and take his last line of levels.

"Throughout the operations described as many good bench marks should be established as possible for future reference. The taking of these levels being done, he should finish his track survey of the river bank up stream to the point at which his first line of cross levels originated.

"With the information so obtained in hand the engineer will be able to make a good sketch, and define approximately the area of the country to be considered, and also to proportion roughly the prism of the upper section of his canal at the head-works."

As a guide to the selection of sites for dams and their construction, M. P. J. Flynn's book on irrigation is strongly recommended. A caution is given against following railroad precedents, a practice likely to lead to error. "Not even that remarkable fungus, the railroad trestle should be used without comparison with other methods."

A scheme for estimating cost of a syphon aqueduct is presented.

In traversing "the instrument should be

clamped at zero on the true meridian and the variation turned off so as to make the needle read zero when the plates are set on the meridian. Each time the instrument is moved and directed to the last point the back reading should remain on the plates. As a consequence, after making the circuit of the polygon and returning to the initial line, if the reading be not the same as before, some error has been made. If the needle be always read it is almost impossible to make a numerical error. No deflection angle is entered in the notes; only the plate bearing. There is not even any necessity to observe whether the direction be right or left, as the protractor graduation will point that out correctly afterwards when the bearings are plotted radially, just as with compass work.

"In any section of country where there is not much magnetic attraction a polygonal traverse, made with a good compass, will close as well, if not better, than one made with a transit instrument. . . This statement based upon the experience of many surveys with both instruments, will be controverted by many engineers, who use only the transit, but by few who have used both.

"Many men use transits that are slightly out of adjustment without taking two points. A traverse made with such an instrument is morally certain to be inferior to one made with a good compass, even where some small amount of local attraction is found at intervals. When a transit is known to be out of adjustment, and is used without double pointing, the same side of the dial should not be used in the same direction twice in succession, but alternately. It is evidently better, however, to adjust it at once, even if it takes a little time.

"Having surveyed the line of canal to its termination as described; a levelled and chained cross section should be made from the end of the canal to the river, and the latter thence traversed up stream, stopping at intermediate points to take long cross sections of the valley back to the line of the canal, at such a distance apart as may be convenient to determine the profile and location of minor channels, *i. e.*, the distribution system. Finally the traverse line is closed at the head of the works where it was begun."

Timber used for trestles should be treated differently from the way it is commonly used upon railroads. "Any engineer who has been in the habit of examining railroad trestles and trusses in use for say three years, will have noticed that the larger the scantling the greater is the splitting and checking lengthwise, and therefore the greater the introduction of moisture that has no opportunity to dry out quickly. This is the case more particularly with timber put into work while green. Timber being a bad conductor of heat, the outer fibre under external influences shrinks much faster than the parts within, the result of this is to split the stick endwise because the inner portion not shrunk forces apart the fibers, reacting against the outer shrinking. This is a point that does not admit of much argument, because we know from actual levels that fourteen 12″ × 12″ sticks of Oregon pine or Douglas fir, built into a crib green, will go down 12 inches in seasoning."

It is concluded from these facts that composite or built-up members are more durable than solid sticks of timber. This important conclusion is illustrated by descriptions of the condition of different structures examined after they have been in use long enough to indicate relative durability. Other important points in practice are given, and the careful perusal of the paper is recommended to all young engineers intending to make irrigation a part of their future business.

An interesting Engineering Feat.

EARLY in 1893 it was decided to alter the grades of portions of the Myrtle Avenue Elevated Railway in Brooklyn, N. Y., and to do it if possible without interruption of traffic. An account of how this was done, entitled "The Myrtle Avenue Improvement on the Brooklyn Elevated Railroad," was given in a paper read at the American Society of Civil Engineers at its October meeting by O. F. Nichols, and is printed with illustrations in the *Railway Review* (Oct. 13).

To properly comprehend the nature of the difficulties to be surmounted it is necessary to understand that the road is an iron structure in the nature of a continuous bridge over the roadway of the street, upon which is a surface tramway doing a large traffic, and which at certain hours of the day is in some of its parts thronged with vehicles. The alterations were to be made without materially interfering either with the street traffic or the regular business of the elevated railway, some of whose grades, as first constructed, had been found too excessive. The superstructure of the road is supported by Phenix posts resting at the bottom upon brick piers. It was decided to shorten these posts at points where alterations were needed by cutting them to the proper lengths, instead of replacing them wholly by new posts; and in order that the work might proceed with sufficient celerity, it was also necessary that a considerable number of the posts should be operated upon simultaneously. The problem of safely supporting the superstructure for a considerable distance in such manner as not to interrupt the traffic either on the structure itself or on the street below, was solved as follows:

"The earlier plans proposed to cut a section out of each column a little above its base, splicing the two parts of the column together with plates riveted on the sides; this avoided the awkward cutting of columns, about 20 in number, on which the drop-end girders extended down the side of the column more than 2 feet; it also retained the rigid connections between columns and girders, which it then seemed wise to rely upon, in part at least, as a safeguard against an overturning tendency."

It was at first contemplated to cut the columns by a cold saw, but the cost of a machine for this purpose caused the project to be abandoned and they were cut by hand. "The columns were firmly fixed by rust joint into heavy cast iron bases about 3 feet square, and these were bolted to the brick masonry piers. It was finally decided to take advantage of the columns themselves to steady the lowering apparatus, and to cut the columns off at the top. Yellow pine timber for lowering was used. All of the vertical sticks were suspended from transverse girders; this avoided all handling of these timbers during the progress of the work. The larger vertical timbers were secured to the girders by built T irons, bolted to the sticks and to the girders to aid in preventing tilting of the girders. Two channel irons held together by four bolts, formed clamps placed near top and bottom of columns to steady the timbers; the middle bolts served as separators, and the end bolts as guides. A space was left between the back of column and the corresponding bolt, to allow the column to spring out ⅝ inch at the top when the girder was lowered into the back channel of the column; this space was filled by wooden wedges at other times.

"Two 60 ton hydraulic jacks were used, one under each of the smaller sticks at each end of the girder. When the larger timbers were placed in position they were left 12 inches short of reaching the main blocking. This space was filled by three carefully dressed blocks 4 inches thick, 14 inches wide and 3 feet long, bolted through edgeways to prevent splitting.

"The brackets were cut between columns and girders, the blocking and vertical timbers were carefully placed, and lock wedges driven under the large timbers to give a firm and uniform support. The side plates and angles forming caps of the columns were then removed and placed in correct position for new caps, the rivet holes having been previously drilled. The horizontal seat plates were cut out to fill the back channel which was to be left intact; the edges of the vertical angles at ends of girders were also cut out to make sure of their entering the channel freely.

"When the sides of the column cap were secured in new position the inside channel of the column was cut off with a heavy diamond point tool held by one man while another struck it with a heavy hammer; the diamond point tool was made of 1 ¼ inch, octagon steel, about 2 feet long, Two men would frequently cut a channel off in two hours; the surface of the cut was afterwards dressed up with a hand chisel and hammer. As soon as the new column cap was completed by adding to its top plate, blocks 6″×6″×18″ were piled on it in pairs and wedged under the end of the girder, to give additional support.

"The cutting of the columns was started at the summit of the grade where it amounted to 5 feet 7¼ inches. When the columns of three bents had been cut, the girders of these bents were at once lowered 4 inches; the columns were sprung out by slacking the wedges at the back clamp bolt and driving other wedges between the column and the heavy timber; and the girders at once entered the channels, which, from this on, formed guides to steady and keep them in place. The cutting was extended until the girders at the summit could be lowered 12 inches. The lowering was done by two gangs of six men each, one on each side street at each of the columns; the superintendent with one gang and the assistant with the other. Two men handled the jack, two the blocking, and the other two adjusted the clamps, which were never allowed to get too slack or drop out of position.

"The jacks had 12 inches left, and had let-off cocks by which the lowering could be checked at any point by the slight movement of a key in the hand of the foreman of the jack. In lowering the jacks were set up to relieve the 4-inch block; this was then backed out, followed by a block 1 inch thinner, and this in turn backed out, followed out by a thinner one in the same manner, In case of accident to the jack the vertical timber could not, therefore, drop more than 1 inch.

"When each girder had been lowered the first 12 inches, it became necessary, if it was to go lower, to saw off the heavy vertical timbers. The girders were then blocked directly on the iron column, the jacks slacked, and the timber sawed off 16 inches. A lowering of 4 inches again brought the blocking to the standard of 12 inches.

"The first blocking was placed on June 1, 1893. The lowering was completed on July 1, 1893. The greatest weight obtainable on any column from structure and trains was 156,000 pounds."

This was truly a very interesting example of engineering work which had few if any precedents, and which required skill, care and forethought for its successful accomplishment. An account of the method of removing the stations, and a statement intended to show that the changes were profitable to the road are added.

Use of Ice Boring Machines for River Surveys.

In the government improvement of the navigation of St. Mary's river, a method of cutting holes through ice by means of an ice auger, instead of by the use of axes and chisels, was found to be an economical innovation. Mr. Joseph Ripley in *Proceedings of the Michigan Engineering Society* (*1894*) describes the method, and the reasons for its adoption. As soundings through ice are frequently one of the most convenient methods of ascertaining the depths of river channels, and as the method of cutting holes through the ice on the St. Mary's saves a great deal of useless labor, *Engineering News* has reprinted Mr. Ripley's paper.

"Having adopted the method of bank measurements in place, as being the most accurate one for determining the amount of material removed above specified grade planes, it was necessary to make detailed surveys of all the shoals. These were generally made in the summer time, but nearly every winter since 1870 soundings have been taken through the ice on the canal or river at places where it was necessary to check the amount of the season's work as estimated from the scow loads, or where it was difficult to sound from boats or rafts on account of the rapids or the frequent passing of steamboats."

At first cavities were chopped in the ice with woodman's axes to as great a depth as the nature of the implement permitted, and then the holes were cut through with an ice chisel. A local machinist, seeing the labor involved in cutting the holes undertook to make an ice auger that would bore 3″ holes. He succeeded in making one that enabled two men to do with it as much as three could with axes and chisels. Improvements made by Mr. Ripley have increased the efficiency of the machine, until two men are now able to do with it the work of twelve with axes and chisels.

"The auger is made by bending a bar of ¾" square steel in a spiral around a bar of 1½" round iron. The best distance for lead of spiral is 2½". The lower end is drawn into a chisel edge, which is widened to 1$\frac{3}{16}$" so as to clear both the inside and the outside of the spiral. Great care has to be taken in sharpening the auger, as one stroke of the file will change the edge so as to make it quick or slow cutting.

"The auger is fastened to the shaft by means of a thread and jam nut on its shank. The shaft is made in sections of 5 feet 1¾ inches round iron. A keyway slot ⅜ inches wide and 3-16 inches deep is cut the length of the shaft. The revolving motion is transmitted to the auger by turning a crank fastened on the shaft of the driver of the bevel gearing; connections being made by means of a lug in the bore of the bevel pinion traveling in the groove of the shaft as it moves up and down.

"An iron tripod 7 feet high is placed on the frame. A line fastened to the swivel on top of shaft and passing through a block hung from top of the tripod is used to raise the auger the instant it cuts through the ice, and holds it up by passing a knot in the line into a U cleat. By holding taut on the line the auger is kept from binding when changing from snow ice to clear blue ice."

The effect of cold on the strength of cast-iron is indicated by the fact that some of the gear teeth broke out in extreme weather when the temperature fell to —30° F.

With a party consisting of "a chief, 2 men for sounding, 6 men to operate three boring machines, 2 men to move tag-lines and mark places where holes are to be bored, 2 or 3 men to shovel snow after the holes are bored, so that the sounders can see the water surface, 1 water-gage observer and 1 cook, Mr. Ripley estimates that 3000 holes can be made in eight hours," and that "the cost would be about $1000 per month." The location of soundings can be made through the ice far more accurately, and the work done cheaper than from boats in the summer.

The Canadian Sault Ste. Marie Canal.

THE near approach to completion of this great work has called forth an interesting editorial in the *Iron Age*, which gives in brief a statement of the commerce of the canal for the last five years. The work is spoken of as "the pride of the Canadians," and as "the last link in a chain of waterways that has cost the debt-burdened Dominion over $67,000,000, and which will at no distant day allow ocean vessels passage to the northern lakes." It is, however, clear that this does not mean such passage immediately, on account of other yet incompleted links on the lower St. Lawrence, "where from reasons best known to itself and the mother country the Dominion is now replacing a canal on the south side of the river by another a little further away from the United States and on the north side."

The changes in the plan, of which there have been three since the work commenced, "to suit the growing commerce of the lakes"; show that only a very partial idea of the probable future of this commerce was entertained by any one at the time the work was projected.

"This new canal is a prodigious undertaking for a country burdened with an enormous debt and of little internal commerce—only 5 per cent. of the last year's commerce of the Sault was in Canadian vessels—for the work has cost over $4,000,000. It has, however, been rapidly pushed, and though begun two years after the new United States canal at the same place, it is completed a year and a half before the date set for the opening of the other. The work has been done as an imperial, and not as a commercial necessity. It is to render the Dominion and its transcontinental highway independent of the United States, and the two events that marked, first its beginning and second, an effort to push it by extra inducements offered its contractors, were the refusal of the United States government to allow the transportation of Canadian soldiers through the American canal in 1885, and the retaliatory measures adopted by Congress in 1891."

"So much has been said of the commerce of the Sault Ste. Marie that it may be unnecessary to say that for the past five years this waterway has exceeded the Suez, and that in 1893, while the Suez passed 3341 vessels, bearing a tonnage of 7,650,000 tons, the American canal, though open only seven months in the year, passed 12,800 vessels and 10,796,000 tons of freight, valued at $145,500,000. The present American canal is so inadequate to handle the traffic that now vessels are often compelled to wait nearly the whole of the 24 hours to get an opportunity to pass; so that the new canal is needed at once. In 1890, while digging for a small water power canal on the Canadian side, workmen came on the remains of a canal built away back in 1796, which had been destroyed by United States soldiers in 1812, and has been forgotten ever since. The first large canal was built in 1855 by the state of Michigan and was afterward turned over to the general government. The entire business of the first two years of this canal is often exceeded in a single day, and the business of the present year to date is more than that of the first ten years of its history.

"But while the Canadians look with pride on this work as bringing to a magnificent conclusion their long and cherished plans, those who know the facts are despondent that there could be built such a work at such cost and under the supervision of the government, and that it should be so defective and so in need, even before its completion, of costly and immediate repairs. These defects are glaring."

Some of the walls are already bulging, some parts of them have been already rebuilt. Bracing and patching have been done in other parts, and a cause assigned for this is the "placing under the massive masonry walls of timber crib work which is unable to hold the weight of the stone."

It is added that this was done when the canal was deepened, and that the water was let into the canal sooner than it would have been, partly to hide this and other defects. In other respects the quality of the work is severely criticised.

The Panama Canal.

An editorial abstract in *The Engineer* (London, October 5) states that a new company having been formed for taking over the works on the Panama canal, it "has issued a report, giving what professes to be an accurate idea of the present state of the canal." The guarded form of this expression indicates a suspicion that the report has been tinged with *couleur de rose*, and the character of the report certainly lends force to such a suspicion. The well-known rapidity with which neglected machinery and implements deteriorate in moist tropical climates, and the impulsive manner of the Chagres river in the matter of its periodical floods, would incline one to expect that after five years' interruption of the work everything would be found in a state of most discouraging dilapidation. The report, on the contrary, represents that "the canal itself has remained practically intact, and the machinery and other plant has only partly deteriorated from the climate." "Partly" is a word of such elasticity that it can stretch all the way from the slightest injury to any point short of total destruction.

An attempt is made to explain away adverse statements on the part of those who have visited the works, by the fact that vegetation is very luxuriant at Panama, that its growth has obscured the real condition of affairs, and that when this has been cleared away, everything will be found in much better condition than it appears to be from superficial examination. It is moreover urged "that so far from being a disadvantage, this growth has actually been of service in preserving the canal, and the vegetation can be cleared away at very little cost.

"After the maritime reach, which terminates at 22.500 kilometers, are the works of the first lock, and these are in an excellent state of preservation. From this point the cutting continues with an embankment 50 meters in height, but notwithstanding the steepness of the sides not a stone has given way; and this is set down to the protection afforded by the dense vegetation. This state of things is unchanged across the plain of Tavernilla as far as kilom. 36; at this point the excavation runs close to the river, from which the water descends during the rainy season. This is particularly noticeable between kiloms. 25 and 28, and between kiloms. 33 and 34. In the middle of the plain of Tavernilla are the large cunettes which, notwithstanding their steep incline, have in no way been affected by the severe floods of four years ago. The works facing San Pablo are also unchanged, though entirely covered with vegetation."

Between the 34th and 40th kilometers the filling up has been rapid. At Matachin, the point for the third lock, the works are in a good state of preservation. At the 46th kilometer "the works for the fourth lock are in good order. . . . A little more than a kilometer further on the banking fell in during the work of cutting."

Similar favorable accounts are given of the condition of affairs over most of the entire length where work has been done; and of the sixteen 120 horse-power dredgers and other machinery ten dredgers are said to be as good as new, six will need extensive repairs, and the rolling stock is not in such poor condition as might be expected. The railways are, however, completely useless until relaid with new ties, the latter being completely rotted away.

The ends sought by the company are considered an enigma by *The Engineer.*

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

26103. William A. McGonagle's Paper on Bridges (R A–Oct. 19.) 1800 w.

26192. The Saginaw Bridge Failure. Ill. (E N–Oct. 25.) 800 w.

*26220. New Victoria Bridge over the Brisbane River. Ill. (Eng L–Oct. 19.) 2000 w.

26309. Concrete Bridge at Munderkingen. Ill. Translated by K. Liebbrand (R R–Oct. 27.) 1500 w.

*26427. Modern Spanish Bridge Engineering. Ill. W. Lodia (P–Nov.) 1000 w.

*26513. Pivoted Arched Bridges (Eng L–Oct. 26.) 2700 w.

26563. A Great Structure.—Something about Cabin John Bridge on the Line of the Washington Aqueduct. Ill. (I Age–Nov.) 1000 w.

26621. Cheap and Serviceable Bridges (M R–Nov. 9.) 700 w.

26634. Certain Changes in the Victoria Bridge. Ill. (R G–Nov. 9.) 700 w.

Canals, Rivers and Harbors.

25840. Use of Ice-Boring Machines for River Surveys. Ill. Joseph Ripley (E N–Oct. 11.) 1400 w.

25841. Canal of the Water Supply and Storage Company of Fort Collins, Col. Ill. F. T. Lewis (E N–Oct. 11.) 600 w.

25849. The North Sea and Baltic Canal (R G–Oct. 12.) 1200 w.

*25856. A Few Points about Dredging (Tr–Oct. 5.) 1700 w.

*25932. The Works at the Panama Canal (Eng L–Oct. 5.) 1300 w.

25944. Effect of Drainage Canal on Level of Lakes (M R C–Oct. 11.) 900 w.

25989. The Great Chicago Canal. Ill. (Sc A–Oct. 20.) 1800 w.

*26043. Canalization of Rivers. Editorial (Eng L–Oct. 12.) 2100 w.

*26148. Ultimate Results of the Chicago Drainage Channel. Ill. G. P. Brown (D E–Oct.) 1800 w.

26168. The Canadian Sault Ste. Marie Canal. (Ir Age–Oct. 25.) 900 w.

26397. The Proposed Lake Superior and Mississippi River Ship Canal. Ill. (E N–Nov. 1.) 800 w.

*26444. The Manchester Ship Canal.—The Cost and Difficulties of Its Construction. Ill. E. Leader Williams (E Rev–Oct. 20.) 1200 w.

*26547. German Waterways and Water Carriage (Tr–Oct. 26.) 800 w.

26591. The Great Chicago Canal (B J C–Nov. 10.) 1700 w.

26632. The Baltimore Ship Canal Project (R G–Nov. 9.) 1200 w.

26655.—$1.50. Hoisting Apparatus of the Canal Head-Gates at Sewall's Falls, N. H. Ill. John R. Freeman, with Discussion (T C E–Sept.) 13500.

Hydraulics.

26191. The Drainage of the Zuyder Zee (E N–Oct.) 25.) 1500 w.

*26336. Pumps (A M S–Sept. 22.) 2200 w.

26356. "Back-woods" Hydraulic Engineering. James F. Hobart (A M–Nov. 1.) 3000 w.

26411. The Flow of Water and Gases Through Long Pipes. G. D. Hiscox (Met W–Nov. 3.) 1600 w.

26480. Water Wheels. Ill. H. L. Aldrich (Pr–Nov.) 3500 w.

26630. A Great Water Power Development Enterprise at Ogden, Utah. W. P. Hardesty (E N–Nov. 8.) 3800 w.

Irrigation.

†26071. Pipe Irrigation. — Wooden Stave Pipe. Ill. S. Fortier, with Discussion (A S I E–1892-93.) 4800 w.

†26072. Continuously Riveted Steel Water Pipe. W. C. Parmeley (A S I E–1892-93.) 2000 w.

†26073. A Reservoir at Santa Fé, New Mexico. Ill. Edward F. Hobart, with Discussion (A S I E–1892-93.) 1800 w.

†26075. The Disposal of the Sewage of Trinidad, Colorado, by Irrigation (A S I E–1892-93.) 900 w.

†26076. Topographic Methods. Ill. Part I. Arthur P. Davis. Part II. Joseph B. Lippincott (A S I E–1892-93.) 3500 w.

†26077. Random Notes on the Survey and Construction of Irrigation Canals. Ill. H. P. Bell (A S I E–1892-93.) 3200 w.

†26078. Expensive Economy.—Errors in Irrigation Schemes. P. M. Narboe (A S I E–1892-93.) 600 w.

†26079. The Operation of Irrigation Canals. Edgar E. Clark (A S I E–1892-93.) 900 w.

†26080. The Necessity in the Engineering Profession for Closer Organization for the Purpose of Mutual Benefit and Support. J. C. Ulrich (A S I E–1892-93.) 4200 w.

†26081. Irrigation in California. W. G. Curtis (A S I E–1892-93.) 1200 w.

†26082. Irrigation Canals in the Caucasus. M. N. Ghierceranof (A S I E–1892-93.) 3000 w.

†26083. The Development of Water Supplies for Irrigation Purposes. F. C. Finkle (A S I E–1892-93.) 2400 w.

*26084. The Rio Grande. F. H. Newell (A S I E–1892-93.) 1500 w.

†26085. The Forestry Problem of the Arid Regions. Arthur DeWint Foote (A S I E–1892-93.) 1500 w.

†26086. State Irrigation, Legislation and the Relation of Engineers and Experts Thereto. Richard F. Hinton (A S I E–1892-93.) 1700 w.

†26087. Concerning Rights in the Water of the Natural Streams of Colorado. F. S. Greene, with Discussion (A S I E–1892-93.) 6500 w.

†26088. A Bill for the Cession of the Arid Lands. A. D. Foote, with Discussion (A S I E–1892-93.) 6000 w.

†26089. Sand Gates in Canals.—A Discussion, Opened by J. S. Titcomb. Ill. (A S I E–1892-93.) 1800 w.

†26090. Discussion on Flumes and Fluming. Ill. Opened by J. C. Ulrich (A S I E–1892-93.) 10500 w.

26372. Irrigated Farm Lands in the Fertile San Luis Valley, Colorado. Ill. (W A–Oct.) 1000 w.

26373. Mexico and Irrigation. Ramon de Ybarrola (W A–Oct.) 2400 w.

26374. Irrigation Engineering. Herbert M. Wilson (W A–Oct.) 2500 w.

*26430. A Practical Illustration of the Duty of Water. Ill. (Mill–Oct.) 1400 w.

Miscellany.

*25788. The Institution of Civil Engineers' Suggestive List of Subjects for Papers for the Year 1894-5 (M W–Oct. 5.) 1000 w.

25844. The Archer Avenue Subway, Chicago, Ill. Ill. (E N–Oct. 11.) 900 w.

25847. A New Method of Determining the Character of Stress. Benjamin F. La Rul (E N–Oct. 11.) 800 w.

*26032. The West Chicago Street Railroad Tunnel, under the Chicago River, near Van Buren Street. Ill. Charles V. Weston (J A E S–Sept.) 7000 w.

26115. The Myrtle Avenue Improvement on the Brooklyn Elevated Railroad. (Abstract.) O. F. Nichols (R R–Oct. 13.) 1900 w.

26189. The Masonry Lining for the Mullan Tunnel, Northern Pacific Railway. Ill. (F N–Oct. 25.) 900 w.

26190. The Brooklyn Bridge, Cleveland, O. Ill. (E N–Oct. 25.) 750 w.

26198. The New Harlem River Speedway, New York. Ill. (ScA–Oct. 27.) 750 w.

26260.—$1. Notes on Certain Field Methods Used on the Survey of the Mexican Boundary in 1892-93. John F. Hayford (A E C U–1894.) 8200 w.

26629. A Rational Theory for the Strains in Columns. A. M. D'Armit (E N–Nov. 8.) 900 w.

26652.—$1 50. Removal of Rock 40 ft. Below Surface of Water, North River, N. Y. Ill. John A. Bensel, with Discussion (T C E–Sept.) 6500 w.

Serials.

22758. The Chicago Drainage Canal. Ill. R R–Began June 9—Ended Oct. 6—16 parts—15 cts. each).

24732. Good Mortars. R. N. Buell (B B–Began Aug.—2 parts to date—30 cts. each).

25445. Clyde Truss Dredging Plant. Ill. (E–Began Sept. 21—Ended Oct. 5—2 parts—30 cts. each).

25521. The Waterway from Chicago to the Gulf. Ill. (Mill–Began Sept.—2 parts to date—30 cts. each).

25661. Module Gate. R. G. Kennedy (I E–Began Sept. 1—3 parts to date—45 cts. each).

25858. The North River Bridge.—Appendices (E R–Began Oct. 13—4 parts to date—15 cts. each).

26048. West India Dock Improvement Works. Ill. (E–Began Oct. 12—2 parts to date—30 cts. each).

DOMESTIC ENGINEERING

Good and Bad Plumbing.

"IF there is that facility afforded by poor plumbing for the entrance of disease to residences that there is claimed to be, then proper plumbing becomes one of the most important of the builders' arts." This is the opening sentence of a good editorial in *The National Builder* (Oct. 13). The recent discussions in the Sanitary Congress at Liverpool have had the effect of arousing public interest in this important subject to an extent hardly equalled by previous discussions. There are yet those who have small faith in the declarations repeatedly made, that diseases frequently enter households through avenues not obstructed by good plumbing.

What is good plumbing? It is not difficult to frame a brief answer to this question in general terms. To specify them in detail would make the answer long. Good plumbing is a system of durable and convenient receptacles, pipes and appliances which permits free flow outward from a dwelling of its drainage, and absolutely prevents inward flow of anything, be it even the most subtle gas or minutest conceivable microbe. An answer is given to those who still doubt. It is an answer also to some who, even if admitting that disease occasionally gains access to dwellings in this way, yet believe such cases are so rare as not to call for special refinement in plumbers' work.

"That bad plumbing is responsible for many diseases which are called contagious there can be no reasonable doubt. It has been investigated too often and too long to permit of any doubt now. If we were allowed a doubt upon this matter now, one would be given the right to doubt any announcement of fact which science has made, and the whole course of scientific investigation could be thrown aside as worthless and misleading.

"There are others who, while they do not dispute that poorly constructed plumbing may become the direct means of communicating these diseases, claim that where bad plumbing exists there will be found every condition necessary for the development of these disease germs should they fall in or about the household. They admit that with bad plumbing these germs of disease have opened up to them avenues by which they may enter rooms much more readily than where the plumbing is good. When they have once entered they find every condition necessary for their growth."

This puts the whole case in very brief yet comprehensive form. Whether diseases enter by routes left insufficiently obstructed or not, when they do enter, bad plumbing affords a nidus for their propagation. "Defective plumbing is in the nature of things intolerable and bad. It does not take a physician to tell us this. Leaky joints, defective pipes, badly set fixtures and the like will, in time, make our houses cesspools, hidden, perhaps, but their pollution will finds its way to our families and take the vigor and vitality from them. If they breed no special disease, the filth and contamination caused by them will vitiate the health, weaken the step, and destroy the suppleness of youth ere the period of manhood or womanhood is reached."

Sanitary plumbing is not a term cunningly devised as a pretext for getting better prices for work, though it has been sometimes made such a pretext by unscrupulous men. Plumbers' trade organizations will, in time, weed out those who are unscrupulous, or incompetent. This is, or ought to be, an object of every trade organization worthy of the name and of the trade it represents, and the effort to effect this is an encouraging feature of modern industry.

Radiator Condensation.

It is well known that the amount of water condensed in a steam radiator in a given time can be made the measure of its heating capacity. More than this, it is the most reliable measure available, and the accurate determination of the amount condensed by different radiators under any fixed set of conditions is the only safe and practicable way of comparing the heating efficiency of equal extent of rated heating surface that has yet been devised. In the October number of this Magazine notice was taken of experiments performed at Stevens Institute by Professors Denton and Jacobus, for the determination of the relative heating efficiency of different radiators. Their investigations, however, were directed to a comparison between plane and extended surface radiators. They found marked differences, not only between these two kinds of heating surface, but also between varieties of extended surface.

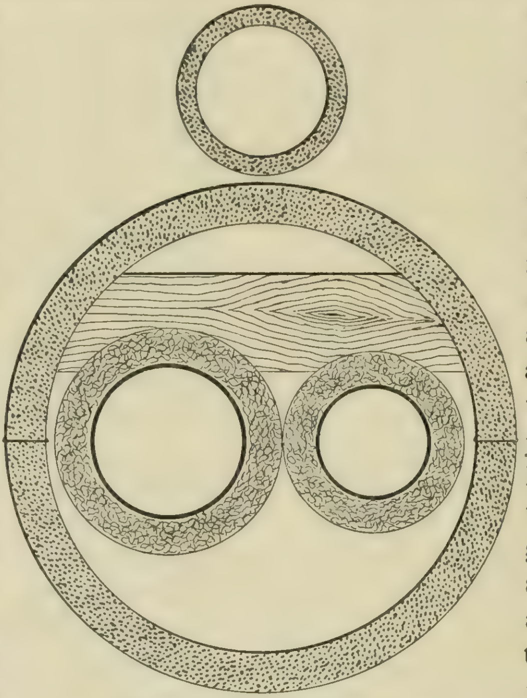
In the transactions of the American Society of Civil Engineers for July, 1894, is an account of a set of experiments performed by Mr. William J. Baldwin, author of a well-known popular treatise on steam heating, who gave an account of them in a paper read at the annual convention of the society held in June of the present year.

Mr. Baldwin's methods were identical in principle with that employed by Messrs. Denton and Jacobus, but the results were indicated by a graphic method, that is to say, they are shown by curves on a diagram accompanying the description of the experiments: A rectangle of convenient size is divided into squares by horizontal and vertical squares. Each horizontal side of one of these squares represents 100 British thermal units. Each vertical side represents two pounds of steam pressure. At the left of the diagram a column of figures indicate these pressures in pounds. At the bottom is a horizontal row of figures that indicate the number of pounds of water condensed, the numbers being respectively placed at the foot of each vertical line. It is evident that on this diagram may now be drawn lines which at any point will indicate the steam pressure, the difference of temperature at that pressure between the steam and the surrounding exterior air and objects, the heating value of a pound of steam condensed to water from any given pressure included in the scope of the diagram, and the condensation from any radiator tested at different temperatures. If the conditions of the tests be kept constant for different radiators, the curves of condensation thus traced form a ready means of comparing their various efficiencies at different temperatures and pressures; and the curves of actual condensation compared with a curve constructed independently to represent the theoretical condensation depending upon temperature difference will enable a determination to be made of the quantity of variation from this which occurs in actual practice.

The following results were obtained with four of the most widely used cast-iron radiators. While the total amount of condensation is greater with higher pressure and temperatures of the steam, exterior conditions remaining practically constant, the heating value of a pound of steam is a very little less at higher pressures than at lower pressures. Again the actual curves of condensation vary so little from the theoretical curve, that in practice it is safe to base estimates of heating capacity upon temperature difference at any pressure available for heating between the limits of say atmospheric pressure and 30 pounds, as indicated by the ordinary steam gage.

Drain, Soil, and Vent Pipes.

"Principles to be observed in plumbing and specifying plumbing for a country house" are discussed in a paper contributed to *The Engineering Record* (Oct. 2) by Albert L. Webster, Civil and Sanitary Engineer. The subject is treated in a practical way without waste of preliminary words, and with an illustration which renders the text more readily understood. "Extra heavy, factory tested, cast-iron pipe is recommended for drain, waste, soil, and vent pipes. Standard cast-iron pipe is too light to permit of the joints being securely caulked; in addition to which the metal in the body of the pipe is too scant, and as the core is frequently eccentric in casting, the pipe is very thin in spots, and blowholes are frequent." Minute and specific directions for putting in these pipes, and the traps in the system, arrangement of vent pipes, and connection of lead pipes with iron pipes are given. Equally exact and comprehensive specifications are given for cleanouts; yard, area, and court drains; safe wastes; drain trap; water closets; bath tubs; basins; sinks; grease traps; slop sinks; laundry tubs, and water supply. The leaving of all pipes as much exposed as possible instead of hiding them under wainscoting and plastered walls is advocated, and avoidance of running water supply pipes on outside walls where they are liable to freeze, is enjoined.



UNDERGROUND STEAM PIPES.

Underground Steam Pipes.

A DESCRIPTION of a method of protecting steam pipes and insulating them to retain their heat when run underground, is reprinted from the Sibley Journal in *Heating and Ventilation.* The accompanying diagram illustrates the method which was carried out in supplying steam to one of the buildings of the Iowa Agricultural College. The method is considered cheaper than the usual way of running pipes underground in brick lined trenches. A point of possible weakness in the method may lie in the wooden chairs used for supporting the pipes, which continuously subjected to heat while excluded from air may not prove durable. Otherwise there seems no objection to it.

" Both the steam and return pipes were laid in the same trench, and were laid with a grade of five-eighths of an inch in ten feet, and drained towards the boilers. The steam pipe was 5, and the return pipe 3½ inches in diameter. The trench was dug to grade. It was about 20 inches wide at the bottom and not much more at the top, the soil being clay, and the season dry. The depth varied from 4¼ to 9 feet. Below the grade of the trench was laid a line of 4-inch drain tile, which was connected with the drainage system of the college grounds.

"The outside covering or conduit for the pipes was constructed of 15-inch vitrified sewer tiles, laid with joints of the best Portland cement. To facilitate the laying the sewer tiles were halved lengthwise by means of a set hammer. It was cheaper to split the tiles than to buy half tiles from the tile works, the cost of whole and half tiles being the same per foot. The corresponding halves were marked for identification and were called uppers and lowers. The lowers were first laid and their joints made with Portland cement. In laying the lowers the proper grade was obtained by a long straight edge and level and verified by the Y-level and rod. At intervals of 6 feet wooden chairs were placed. These were sawed from 2-inch plank to fit the inside of the tiles and the outside of the covering of the steam and return pipes, and were dipped in asphaltum paint. The steam and return pipes were laid upon these chairs, two or three lengths being screwed together at one end for a start. The first section of each pipe was raised from the chairs, first at one end and then at the other, to allow of the placing of the non-conducting covering. Then two more lengths of each pipe were added to the line and the covering applied by raising the advancing end to clear the chairs by the necessary amount, and so on until the whole line was laid and covered. The uppers were then placed and all the joints made in Portland cement. Back-filling completed the job. Expansion was provided for by ample offsets at the ends of the line. The non-conducting covering used on the pipes was mineral wool sectional covering; the sections were joined with pasted strips of heavy paper and cloth."

Typhoid Fever Germs and Sewerage.

IN the proceedings of the Sanitary Institute Congress, as reported in *The British Architect*, a paper of Dr. Klein on Typhoid Fever germs, and another by Prof. A. Roche (Dublin) on the spread of Typhoid Fever by sewers, both indicate that sewers may be avenues of conveyance of this disease to places not previously affected.

Dr. Klein's remarks related mostly to the typhoid bacillus, and pointed out the characteristics of *bacillus coli* by which it is distinguished from the true typhoid bacillus. Prof. Roche dealt with the conveyance of these germs through sewers. To prevent this ought to be the aim of the hygienist, and the safest and surest way of disposing of typhoid discharges was undoubtedly to destroy them by heat. All hospitals and public institutions should be obliged to do that.

Sir Charles Cameron (Dublin) argued that the evidence with regard to the spread of typhoid fever by milk or by water or through the sewers was of the very feeblest character. In Dublin they had a splendid water supply and a good system of sewerage, but their death-rate as to typhoid was one of the worst in the kingdom. The typhoid germs needed to be destroyed in the sick room itself, as once it was free there was no telling how it spread.

Dr. Sykes (St. Pancras) urged that bad drainage was very frequently responsible for the spread of typhoid. Dr. Clare (Hanley) remarked that the medical officer for Newcastle had attributed the immunity of that town from typhoid to the fact that it was built on a clay soil. Now Hanley and other of the "Potteries" towns were built on clay, and they had typhoid. The water was good, and the only conclusion he could come to was that the infection came from the manhole ventilators of the sewers, as the infected houses were those nearest the ventilators.

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The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

26026. Determining Size of Pipes and Registers to Heat a Given Amount of Space. George D. Hoffman (Met W–Oct. 20.) 800 w.

26417. Underground Steam Pipes. Ill. (H & V–Sept.) 450 w.

26418. New Electrical Heating Apparatus. Invention of H. Ward Leonard (H & V–Sept.) 600 w.

26421. The American Society of Heating and Ventilating Engineers. Suggestions for Its Advancement (H & V–Oct.) 5000 w.

26471. Steam Plant of the Grosvenor-Dale Company. Ill. (E R–Nov. 3.) 1800 w.

*22600. House Heating in Northern Countries (I S F–Nov.) 1000 w.

Landscape Gardening.

25807. Landscape Art and the Harlem Speedway (G & F–Oct. 10.) 1100 w.

26322. Transplanting Trees (G & F–Oct. 31.) 1200 w.

26323. Climbing Plants on Boston Buildings. Sylvester Baxter (G & F–Oct. 31.) 2000 w.

Plumbing and Gas Fitting.

26066. Principles to be Observed in Planning and Specifying Plumbing for a Country House. Ill. (E R–Oct. 20.) 2700 w.

25940. Good and Bad Plumbing (N B–Oct. 13.) 900 w.

*26149. The Plumber and the Sanitarian. John Mitchell (D E–Oct.) 1600 w.

Miscellany.

*25863. The Sanitary Institute Congress (B A–Oct. 5.) 2300 w.

*25904. Disease Caused by Sewer Gas, etc. (Pl D–Oct.) 900 w.

26419. Smoke (Abstract) W. H. Blauvelt (H & V–Oct.) 700 w.

26420. In the Time Before Chimneys. Ill. E. C. Weaver (H & V–Oct.) 2200 w.

Serials.

25500. Gas Stoves as They Are and as They Should Be. Adam Gasmann (P A–Began Oct. 1—2 parts to date—15 cts. each).

25716. Power and Heating Plant, Manhattan Life Insurance Building. Ill. (E R–Began Oct. 6—2 parts to date—15 cts. each).

26132. Sanitary Plumbing. F. B. Brady (I C B–Began Oct. 12—Ended Oct. 19—2 parts—30 cts. each).

ELECTRICITY

Defective Telegraphic Construction.

On election day in November occurred one of those periodical storms, consisting of a combination of rain, snow and ice, which once in every two or three years make a total wreck of the telegraphic lines over a wide area of country. The damage in the present instance seems to have been mainly confined to a section of country between New York and Boston, within which area, according to the statement of a local newspaper, over 8000 poles were thrown down, and their burden of wires tangled into almost inextricable confusion. The *Springfield Republican* (November 13) calls attention to the fact that the Western Union company are replacing and resetting the same old poles, and sarcastically inquires whether that company is not getting ready to unload its decayed poles and wires on the United States government at a round price, when popular patience has been quite exhausted. It is hardly necessary to assume so far fetched an explanation as that. The trouble is, not that the poles are weak or decayed, but that they are overloaded. Each line of poles carries three or four times as many wires as it should, either for satisfactory operation, or for safety in case of a severe storm. The poles are usually not broken under the added weight of snow and ice, but are simply pried out of the ground. Every highway and railway between New York and Boston is already inconveniently crowded with lines of poles, and every line of poles is overburdened with wires. There would seem to be only two ways out of the difficulty. One is for the telegraph companies to purchase an independent right of way 50 or 100 feet wide, between the principal cities, and erect thereon a structure strong enough to withstand such storms as that of last month, or else the trunk lines must be put underground. A few years ago, the latter alternative would have been almost an impossible one, within reasonable limits of cost. But so great have been the improvements in the manufacture of insulated wire and cables, that it is an open question whether, if it were to-day required to build a new line of 100 wires from New York to Boston, an underground line would not be the cheapest in first cost, to say nothing of the subsequent expense of maintenance, and the advantage of being able to operate every circuit at full speed at all times, regardless of the condition of the weather. Nothing is more certain than the fact that the present system of construction has reached the limit of its usefulness on such main routes as that from Boston, to New York, Philadelphia, Baltimore and Washington.

Electricity on Elevated Railroads.

The question whether the elevated railroad of the future will be operated by steam or by electric locomotives has given rise within the past year to no small amount of discussion. "With the Metropolitan of Chicago now equipping twenty miles of elevated road for electric traction at a cost of $400,000 more than steam equipment would have necessitated; with the Northwestern arranging to equip electrically, and the Lake street and Alley 'L' companies wishing they had done so, it would seem,"—says Mr. B. J. Arnold in the *Western Electrician* (October 10),—"that the question has been pretty effectually settled in favor of electricity by those most competent to judge." Mr. Arnold believes the elevated road of the future will be built substantially on the following general lines: "The structure will be of steel, about two-thirds the weight of the present structures built for steam service. The current will be carried to the trains by a trolley-line consisting of a cheap grade of railroad rails, which it has been found can be purchased and laid for but little over half the cost of copper conductors of a given conductivity, or by a specially rolled square steel bar. The active or 'live' trolley will be supplemented by one or more similar rails or bars as the distance from the power-house and the number of trains increase. Sliding-contact trolleys have thus far proven preferable, and will probably be adhered to for future work at higher speeds. So far as present indications point, we shall maintain the direct current motors attached directly to the axles of the forward or motor car. . . . Comparisons between the Liverpool overhead railroad and the City & South London underground lines show that the tractive force per ton of locomotive is as 730 to 367, or a ratio of nearly two to one in favor of the motors mounted directly on the motor car." Mr. Arnold thinks the electric brake of the future will be operated by the counter current generated by the motor armatures, and will be entirely independent of the current from the trolley or any external source. "In the power-station, the tendency will be towards larger and fewer units of power, resulting in decreased cost for labor and repairs. Direct coupled engines and generators will be used exclusively. A well designed and properly operated power-station should be able to deliver a kilowatt hour on the switchboard for one cent, exclusive of motormen's wages and interest, but including all labor, fuel and miscellaneous expenses incidental to the production of power." Mr. Arnold gives a table showing the estimated cost of power for operating an elevated train of various weights at various speeds, assuming the price of bituminous slack at $1.25 per ton. According to this, a 6-car train at 15 miles per hour, will cost 12.46 cents per train mile. These figures, he thinks, ought to be possible under present practice.

The Heilmann Locomotive.

THE *Railroad Gazette* (November 9) contains a long editorial on this much discussed and apparently absurd contrivance for combining steam and electric traction, which has been in experimental use during the past year on the Western railroad of France. Now that this railroad has undertaken to build two more of these machines, with certain modifications and improvements, and inasmuch as various technical writers have thought it worth while to discuss it as a possible machine for practical service, the *Gazette* has sought to make a somewhat critical analysis of the theory underlying its construction and of its working details. The new engines are to have two eight-wheel bogie trucks and eight electric motors, one truck carrying the boiler and the other the engines and dynamo. Each locomotive is provided with a 1500 horse-power vertical Willans engine and a dynamo of corresponding capacity. The boilers are of the ordinary locomotive type. The claims made for the Heilmann locomotive are, that with it, higher speed can be made with greater safety, less injury to the track and with considerable economy of fuel. The *Gazette* compares the performance of the Heilmann machine, as given by Mr. Du Riche Preller in a recent number of *Engineering*, with that of a typical engine of the New York Manhattan railway in this country, very much to the advantage of the latter. It says that "the average local train service in this country is much heavier than that performed by the Heilmann motor; the trains are about four times as heavy, the speeds as high or higher, and the locomotive and tender combined are only about half the weight of the Heilmann motor. Four times the work in every-day service is done with about half the weight of locomotive." The writer of the article then goes on to compare the two systems, by showing what can be theoretically got out of a pound of coal in each. He figures that in the Willans engine, under the conditions given, a horse-power hour can be produced from 3.84 pounds of coal, as against 4.34 pounds in a compound locomotive running under fair conditions. Allowing 8 per cent. loss in internal friction for the steam locomotive, and 10 per cent. for the Willans engine and its dynamo, plus 10 per cent. allowed for average loss in the dynamo under varying load, each horse-power hour of current will require 4.8 pounds of coal. The efficiency of the motors is taken at 70 per cent., which is surely high enough, and this brings the coal per horse-power hour to deliver at the driving axle 6.85 pounds as against 4.73 pounds required by the steam locomotive. Hence the Heilmann locomotive will require 45 per cent. more fuel than the steam locomotive to do the same work, to say nothing of its being twice as heavy. "No one," says the *Gazette*, "who has not examined the details of construction of the Heilmann motor, can appreciate the mass of complication of detail. It has all the disadvantages of the hard-driven locomotive boiler; the locomotive running-gear, cylinders, electric generating plant, a small steam-engine for exciting the field-magnets, eight electric motors with their commutators and brushes, eight or sixteen flexible clutches, and eight hollow shafts surrounding the driving axles; in fact it has all the troubles incident to a stationary electric plant, an electric street-car and a steam locomotive combined, and has not the advantages of any one of these."

The trials which have been made with the Heilmann motor appear for one thing to have demonstrated the inadequacy of the three-phase alternating motor, as at present constructed, for railroad service. Such a motor was designed for the Heilmann machine by C. E. L. Brown, but finding that it had insufficient starting torque, he finally returned to the plain series-wound motor, which so far appears to hold its place as the only type suitable for use under the necessarily varying conditions of speed and load in railroad work, where frequent stops must be made at crossings, for signals and at way stations.

Conditions of Maximum Economy in Electric Conductors.

In 1881, Sir William Thomson, now Lord Kelvin, read before the British Association a most important paper on the conditions of maximum economy in the transmission of electric energy, in which the conclusion was reached that this maximum is secured when the cost of power wasted is equal to the cost of interest, depreciation, repairs, etc., on that part of the cost of the line that increases with the cross section of the conductor. In the *Electrical Engineer* (October 31) Professor W. A. Anthony observes, that notwithstanding that Professor Ayrton had pointed out some years since, that Kelvin's law held good only in certain cases, the idea still seems to be generally prevalent that it has a general application. Prof. Anthony goes on to cite a number of examples involving conditions which might, and in fact, do, often occur in practice. in which the application of Kelvin's law leads to results which are manifestly absurd. One of these is the case of a water-power in which it is desired to employ the whole power to the best advantage while the admissible pressure is limited by conditions of line insulation. In such a case, the problem is, not to deliver a certain fixed quantity of energy at the least possible expense for transmission, in the form of additional energy and interest and repairs on line, but to divide the energy available into two parts, one to be delivered and the other to be used to effect the transmission, in such manner that the returns from the part transmitted shall bear the largest possible ratio to the total cost of generation and transmission. The application of Kelvin's law to this case might, and often would, give such a size of conductor that the entire available energy would be consumed in it. Professor Anthony points out that there may be as many as eleven different cases in all, most of which may be solved for a condition of maximum economy, but in only one of which this condition is satisfied by the conditions laid down in Kelvin's law. He regards it as a self-evident proposition that the maximum economy in any given case will be reached when the revenue from the energy delivered bears the largest possible ratio to the total expense of generation and transmission. When the quantity of energy to be delivered is given, the condition of maximum economy is that the cost of transmission shall be a minimum. When on the other hand, the quantity of energy that can be generated is given, the condition of highest economy no longer requires that the cost of transmission thall be a minimum, since that might in some cases demand the entire available energy merely to effect the transmission. Professor Anthony also takes occasion to criticise the employment of the term "waste energy" to denote the energy consumed in transmission. In transporting coal from the mines to the consumers, no one thinks of calling that part of the coal which is used in the locomotives "waste coal." What is miscalled "waste energy" is an entirely legitimate part of the expense of transmitting energy from the transmitter to the receiver, and is no more waste in any proper sense than are interest and depreciation.

Sine Curves of Alternating E. M. F.

A COMMUNICATION from Siemens & Halske of Germany relating to this much-discussed subject appears in the *Electrical World* (October 20). The authors distinguish three typical forms of curve; the flat-topped curve, the peaked curve and the sine curve, which lies between the first two forms. So far as incandescent lamps are concerned, the form of the curve appears to be immaterial, but in operating arc lamps, it is of considerable importance. The potential difference between the carbons of a burning arc lamp, other things being equal, is greater in proportion as the curve is flatter. With a peaked curve this potential difference is 25 per cent. less than with the flat curve. The amount of light produced per watt consumed in the lamp is also 20 per cent. less. The humming noise of the arc lamp is less with a sine curve than either with a peaked or a flat curve. In transformers and motors, the peaked curve has the advantage over the flat form in that with the same mean e. m. f. the energy of magnetization is less. In an experiment quoted, the energy of magnetization was found to be 43 per cent. higher in the case of the flat curve. This however, but slightly lowers the efficiency of the conversion as a whole. The torque and output of a motor are not much influenced by the form of the curve. The authors point out that dynamos giving different curves cannot advantageously be run in parallel, and that arc lamps must be regulated for the special form of curve for which they are to be used. From these and other considerations the authors think that it would be very advantageous if all makers of alternate current apparatus would decide to use some one form of current curve. It would be an advantage to choose a curve having as simple a mathematical formula as possible; a condition which is satisfied by the sine curve, which is therefore recommended as the form to be preferably chosen as the universal current curve in alternating practice.

Electric Lighting of Isolated Buildings.

FOR some reason or other, comparatively little has been done in this country in the way of providing an efficient and economical means for electrically lighting first-class residences situated in isolated localities. Thus far, probably nothing better has been devised than a storage battery plant of adequate capacity, arranged to be charged by a dynamo driven by a gas or petroleum engine. A somewhat verbose description of an interesting plant of this kind is given in the *Western Electrician* (October 13) accompanied by a number of illustrations. The power-house containing the electric apparatus is situated about 500 feet from the mansion to be lighted. The latter is wired on the three-wire system, the conductors being placed in interior conduits. A Lewis 15 horse-power gasolene engine is belted to a 12 k. w. shunt-wound Edison dynamo, giving 125 volts and 96 amperes at 1600 revolutions. The storage-battery consists of 60 chloride accumulator cells aggregating 250 ampere-hours' capacity. These are placed on shelves in four vertical rows of 15 cells each. A switchboard of black slate carries all the necessary instruments and appliances. The buildings are at present wired for 256 lights. In operating the plant, the usual practice is to run the dynamo during the day to charge the storage-battery, and to run the house lights at night directly from the battery. In the event of an unusual load, the dynamo may be thrown into service and current furnished direct for the entire lamp capacity of the plant. It is computed that the average cost of running 100 lamps 4 hours per day, including gasolene, lamp renewals, oil, etc., but not depreciation of storage battery is about $26 per month.

Electric Distribution in Small Towns.

THE *Electrical Engineer* (October 31) has an interesting account of an electric plant at Buchanan, Mich., a town of about 2500 inhabitants, which is operated by water-power from the St. Joseph river. The electrical equipment at the power-house comprises one 45 kilowatt 500-volt generator for motor work; one 65 kilowatt 1000-volt alternator, and one 60-light 10-ampere arc dynamo. These are driven by three turbines of 150 horse-power each, mounted on vertical shafts and driving a single main shaft by bevel-gears, at a speed of 250 revolutions per minute. The pulleys which drive the dynamos are mounted on quills on the main shaft and provided with friction clutches, so that any pulley may be started or stopped at pleasure. The present output comprises 700 16 candle-power incandescent lamps; 45 2000 candle-power arc lamps, and motors aggregating 55 horse-power. The consumption is rapidly increasing. The price for commercial and public arc lights, running till midnight, is $50 per year; for commercial 16 candle-power lights, $6 per year, and for domestic lights, $18 per year for the first three lights and $1 per year for each additional light, the customers paying for renewals. For motor service, $20 per horse-power per year is claimed for over 50 horse-power, and $25 per horse-power per year for less. Three men run the entire plant both for day and night service.

Fly-Wheel Accidents in Electric Power-Houses.

IN the *Electrical World* (October 13) appeared a communication from Mr. T. C. Coykendall, suggesting as an explanation for the somewhat numerous instances of the breaking of fly-wheels in electric power stations within the past two or three years, the tangential stress caused by the sudden and heavy load thrown on the engine upon the occurrence of a short circuit on the dynamo. In the same journal (October 20 and 27 and November 3 and 10), the subject-matter of Mr. Coykendall's letter is discussed at length by a number of eminent authorities in mechanical engineering, among whom may be mentioned Professor R. H. Thurston, Charles E. Emery, William D. Marks, and T. Carpenter Smith. The general consensus of opinion appears to be that such disasters seldom arise from the particular cause assigned by Mr. Coykendall, but are in almost every instance found to be due to some defect either in the construction or operation of the governor, which permits the engine to race and to suddenly increase the centrifugal strain upon the fly-wheel beyond the safety limit. Mr. Smith says he has kept a rough list of such accidents for two years and finds that there have been over thirty of them, causing a large total damage as well as the loss of several lives. He calls attention to the fact that but few of these accidents have occurred in rolling-mills, where the variations in load are as great if not greater than in the electric service and are always accompanied with a much more sudden shock or jar, but on the other hand most of them have happened in the manufacturing or electric service in which the wheels have not only served as fly-wheels but also as transmission wheels, the power being taken off the rim either by belts or gears. Mr. Smith also notes that in nearly every reported case the wheels have been of large diameter and the speed of the engine either slow or moderate, and adds that he has not on record a single case of a really high-speed engine having broken either a fly- or transmission-wheel. This would seem to indicate that immunity from such accidents might be had in the use of heavy wheels of small diameter driven at high speed. The question is one of great practical importance as well as theoretical interest, and the *Electrical World* deserves the thanks of the profession for having opened its columns to a discussion of the matter at the hands of so many recognized authorities.

Cost of Electricity in a Temporary Plant.

ACCURATE figures giving the cost of producing electricity for light and power under different conditions met with in practice are always of value, and those deduced from the working of the temporary plant erected for the California Exposition, are of peculiar interest. These are given in great detail in a paper by W. F. C. Hasson and A. M. Hunt in *Electricity* (October 17). There were throughout the Exposition a total of 791 arc and 9112 incandescent lights; the hours of incandescent service were 1937, and the charge was $8 per lamp; the days of arc service 154, and the charge $75 per lamp. The total cost of materials and labor for installing the electric plant was $15,061.37. The total cost of installation and operation per 16 candle-power lamp, during the period of the exposition, was for the Electrical department $2.30; for the Engineering department $2.49; grand total $4.79. In considering the cost of operation above given, the authors call attention to the fact that the plant was in no sense well designed for economic operation, inasmuch as both engines and dynamos were operative exhibits which had to be matched together as well as circumstances would permit. It is stated that if all the construction had been done by the Exposition forces, the cost of the work would have been at least 35 per cent. less than it actually was. These figures may be of value in estimating the cost of future work of a similar nature.

Compounding of Dynamos.

THE strength of the magnetic field of a dynamo depends upon the number of ampere turns enveloping its magnetic circuit. When, therefore, an increased current is drawn from the armature, a corresponding augmentation in voltage is required to drive this increased current through the armature, and this can only be provided by strengthening the field. A shunt-coil cannot do this, for the current in the shunt necessarily tends to diminish as the load becomes greater. Hence an additional coil is placed upon the field which is connected in series with the armature, and in this coil the current will evidently increase as the load increases. This operation is termed compounding the dynamo. In some of the text-books, the dimensioning of the series coil is made to appear to be a very complicated matter, though in reality nothing can be more simple. Mr. George T. Hanchett, in the *Electrical World* (November 10), gives a method of practically determining the number of turns which should be given to the series coil of a compounded dynamo, together with an illustrative example which makes the whole matter quite clear, and may be commended to the attention of those interested in the subject. Mr. Hanchett points out that inasmuch as the series coils of a compound machine are nothing more than regulators for the magnetic reactions of the armature and the lost volts consumed in driving the current through its coils, the excellence of the design of any given machine may be roughly estimated by regarding it as inversely proportional to the number of turns in the series coils, inasmuch as the lost volts and armature reactions of a good machine are very small.

Welsbach Burners vs. Electric Lamps.

HOW to meet the competition of gaslight, as furnished by the Welsbach burner, with electric light at the lowest figure at which the latter can be supplied is a conundrum propounded but left unanswered by Mr. Ed. M. Highland in *Electrical Engineering*. "To compete with gas we must get an equal amount of light, in candle power, per pound of coal used, or be able to deliver the product to the consumer at a proportionately cheaper rate than gas is being delivered. The committee on statistics of the National Electric Light Association report 208 watt hours per pound of coal as the best duty, and gives the average of sixty-five electric light plants as 91.6 watt hours per pound of coal. This average is entirely too low to use even in argument. So we will take the best showing made, 208 watt hours. This 208 watt hours will supply 3.7 incandescent lamps of sixteen candle-power each of the type known as 3½ watt per candle efficiency, making a total of 59.2 candle-power per pound of coal. The same amount of the same kind of coal consumed in a gas-works will yield four cubic feet of gas. The Welsbach burner consumes three feet of gas per hour and gives a sixty candle power light, or the equivalent of eighty candle-power per pound of coal." A comparison of expenses other than coal is very much in favor of gas lighting as compared with electric lighting; and the conclusion seems unavoidable that "electricity is sold as cheap now as it is possible with present machinery. Gas can be sold from twenty-five to fifty per cent. less than at present, and still leave a good margin for the stockholders. How can electric light companies meet this competition?"

Mr. Perry's article printed in this Magazine for November, offers at least a partial answer to this question.

Another partial solution is perhaps afforded in the paper of Lieut. F. N. Lewis, on the generation of electric power by windmills, printed in this number, which contains some statements relative to economies secured by the use of wind-power that will command attention.

It is also possible that Mr. Highland's figures may be disputed, as there is always danger of overlooking something in estimates of this sort.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Lighting.

25853. Storage Batteries for Private House Lighting. Ill. (W E–Oct. 13.) 1800 w.

25866. On the Subdivision and Distribution of Artificial Sources of Illumination. William A. Anthony, with Discussion (P A–Oct. 15.) 5000 w.

25951. Storage Battery Decision. Letter from W. W. Gibbs (E R N Y–Oct. 17.) 1200 w.

*26056. The Electricity Works at Worcester. Ill. (E E L–Oct. 12.) 7000 w.

26140. Fire from Contact with Electric Wires. William Brophy (A G L J–Oct. 22.) 2600 w.

*26218. Notes on the Electric Lighting of the City of Melbourne. (Abstract.) J. Arnot (I. & I–Oct. 19.) 2500 w.

26247. A Review of the Underwriters' Recent Rules Covering the Use of 500 Volt Fuses. Walter E. Harrington (W E–Oct. 27.) 1800 w.

26370. A Dresden Electric Plant. Ill. Robert Grimshaw (E W–Nov. 3.) 1500 w.

26385. Charges for Incandescent Lighting by Southern Stations (T–Nov. 1.) 1600 w.

*26435. On the Degree of Incandescence of Lamps. A. Crova (El–Oct. 26.) 1000 w.

Power.

*25764. Generating Electricity by Wind Mills—A New Factor in Power Transmission. Ill. I. N. Lewis (E Mag–Dec.) 3500 w.

*25877. The "Halles" Station. G. Claude (E R L–Oct. 5.) 3800 w.

†25965. Test of a Closed Coil Arc Dynamo. Ill. R. B. Owens and C. A. Skinner, with Discussion (T A I E E–Oct.) 3500 w.

†25966. Relative Advantages of Toothed and Smooth Core Armatures. Alton D. Adams, with Discussion (T A I E E–Oct.) 3300 w.

†25972. Theory of Two and Three Phase Motors. Samuel Reber (T A I E E–Oct.) 1800 w.

†25973. Theory of the Synchronous Motor. Charles Proteus Steinmetz (T A I E E–Oct.) 2400 w.

*26234. Electric Power in Factories. (Abstract.) Thomas Richardson (El–Oct. 19.) 3800 w.

26298. Electric Elevators. Ill. George Edward Harding (A A–Oct. 27.) 6500 w.

26329. Economical Production of Power by Electrical Driving (E N Y–Oct. 31.) 2500 w.

26346. The Earliest Electric Passenger Boats and Passenger Cars (ScA–Nov. 3.) 900 w.

*26433. Electric Traction by Accumulators in Mines (El–Oct. 26.) 1100 w.

26534. The Water-pail Forge and Modifications. Nelson W. Perry (E N Y–Nov. 7.) 1700 w.

26594. Practical Compounding of Dynamos. George T. Hanchett (E W–Nov. 10.) 1500 w.

Telephony and Telegraphy.

*26061. Notes on the Anglo-American Telegraph Company's 1894 Electric Cable. Ill. Arthur Dearlove (El–Oct. 12.) 1900 w.

Miscellany.

25772. A Simple Formula for Magnetic Windings. Fred Brainerd Corey (E E N Y–Oct.) 500 w.

25835. Relation Between Line Wire Losses and the Over Compounding of Dynamos. E. P. Roberts (E W–Oct. 13.) 1000 w.

25852. The Electric Era.—The South's Advancement in Electric Railroad and Light and Power (M R–Oct. 12.) 3000 w.

25937. Cost of Light and Power for a Large Temporary Plant. W. F. C. Hasson and A. M. Hunt (E N Y–Oct. 17.) 1500 w.

†25967. Standardizing Electrical Measuring Instruments. Elmer G. Willyoung, with Discussion (T A I E E-Oct.) 6200 w.

†25968. An Optical Phase Indicator and Synchronizer. Ill. George S. Moler and Frederick Bedell (T A I E E-Oct.) 1200 w.

†25969. A Reliable Method of Recording Variable Currents Curves. Albert C. Crehore, with Discussion (T A I E E-Oct.) 4000 w.

†25970. Resonance Analysis of Alternating and Polyphase Currents. M. I. Pupin (T A I E E-Oct.) 7000 w.

25984. The Riker Storage Launch Operated from Trolley Circuit at Stamford, Conn. Ill. (E E N Y-Oct. 17.) 600 w.

†26037. "What Electricity Is" (N S R-Oct.) 2400 w.

26102. The Oscillator.—An Account of Nikola Tesla's Great Invention. (From the N. Y. Times.) (R A-Oct. 19.) 1700 w.

*26126. Modification of Anderson and Kennelly's Method of Localizing a Fault by the "Earth Overlap Test." A. Jordan and W. Schönan (E R L-Oct. 12.) 500 w.

*26129. On Persistent Electric Oscillations and Their Effects. H. Ebert (E R L-Oct. 12.) 1500 w.

26195. Hertzian Waves, Carbon Microphones and "Coheres." William James Morton (E E N Y-Oct. 24.) 1000 w.

*26237. Capacity of Conductors (E R L-Oct. 19.) 900 w.

26341. On Economy in Conductors and the Limitations in the Applicability of Kelvin's Law. William A. Anthony (E E N Y-Oct. 31.) 2000 w.

26347. High Voltage Electric Shock Produces Insensibility to Pain (ScA-Nov. 3.) 700 w.

26371. Cost of Light and Power for the California Midwinter International Exhibition. W. F. C. Hasson and A. M. Hunt (E W-Nov. 3.) 1000 w.

26414. The Magnetic Needle. A. W. Elkins, with Discussion (C M R-Oct.) 2500 w.

*26524. Earth Currents. E. O. Walker (E R L-Oct. 26.) 1500 w.

*26526. Choking Coils vs. Resistances. Rankin Kennedy (E R L-Oct. 26.) 700 w.

*26528. Regulation of Phases in Working with Alternating Currents. Ill. C. L. Imhoff (E R L-Oct. 26.) 700 w.

26618. New Monocyclic Alternating System for Simultaneous Light and Power Work. Ill. (E I-Nov.) 1300 w.

Serials.

11560. Electric Motive Power. Ill. Albion T. Snell (El-Began March 17, 1893—22 parts to date—30 cts. each).

18661. Alternate Current Working. Harris J. Ryan (E W-Began Jan. 6—8 parts to date—15 cts. each).

11932. What I Don't Know About Electricity (E I-Began Feb.—3 parts to date—15 cts. each).

22059. Practical Notes on Dynamo Calculations. A. E. Wiener (E W-Began May 19—16 parts to date—15 cts. each).

23866. Electro Dynamic Machinery. E. J. Houston and A. E. Kennelly (E W-Began July 21.—15 parts to date—15 cts. each).

24198. Action of a Transformer with a Condenser in Parallel with the Secondary. F. Bedell and A. C. Crehore (E W-Began Aug. 11—4 parts to date—15 cts. each).

24508. Magnetic Leakage in Dynamo Electric Machinery. Ill. Alfred E. Wiener (E E N Y-Began Aug. 22—Ended Nov. 7—10 parts—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A-Began Aug. 25—9 parts to date—15 cts. each).

25095. Postal Telegraphs. James Bell (E L-Began Sept. 7—8 parts to date—30 cts. each).

25105. Standard Units for Electrical Measurement. (E R L-Began Sept. 7—4 parts to date—30 cts. each).

25129. The Incandescent Electric Lamp Problem. Sydney F. Walker (C G-Began Sept. 7—2 parts to date—30 cts. each).

25482. The Chemical Theory of Accumulators. E. J. Wade (El-Began Sept. 21—5 parts to date—30 cts. each).

25483. The Construction of Resistances. D. K. Morris (El-Began Sept. 21—Ended Oct. 5—3 parts—30 cts. each).

25599. Notes on the Management of Railway Power Stations. Ill. George T. Hanchett (E W-Began Oct. 6—5 parts to date—15 cts. each).

25743. The Board of Trade Standards and Standardizing Laboratory (E E L-Began Sept. 28—2 parts to date—30 cts. each).

25876. The Electric Motor and Some of Its Applications. Ill. (E R L-Began Oct. 5—2 parts to date—30 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (E L-Began Oct. 5—4 parts to date—30 cts. each).

25897. The Velvo Battery with Mechanical Depolarization. Critical Review of Tests (E L-Began Oct. 5—1 part to date—30 cts).

25907. The Alternating Current, Its Generation and Distribution. George D. Shepardson (E I-Began Oct.—2 parts to date—15 cts. each).

26235. The Diseases of Dynamos. (E R L-Began Oct. 19—2 parts to date—30 cts. each).

26377. Resonance Analysis of Alternate Currents. M. I. Pupin (A J S-Began Nov.—1 part to date—45 cts).

26518. The Surplus and Deficit Theory of Electricity. W. Perren Maycock (E E L-Began Oct. 26—1 part to date—30 cts).

26592. Electrical Power Transmission. Louis Bell (E W-Began Nov. 10—1 part to date—15 cts).

INDUSTRIAL CHEMISTRY

Recent Applications of Cellulose.

AN interesting popular account of the preparation of pure cellulose and of the many remarkable and valuable products, old and new, derived from it appears in *Knowledge*. While cellulose is insoluble in ordinary solvents, it yields to some special reagents, of which the most important are the ammoniacal solution of cupric hydrate and the solution of zinc chloride in hydrochloric acid. The solvent power of the former is the basis of the manufacture of "paper boards," made by submitting sheets of unsized paper to a superficial action of the solvent and compressing a series of prepared sheets by rollers, the result being a board-like material waterproof even at the boiling point.

Nitric acid acting on blotting paper produces a curious result; the composition remains unchanged but the strength of the paper is increased tenfold, while the linear extent is decreased 10 per cent. Stronger nitric acid and mixtures of nitric and sulphuric acids, acting on cellulose, produce gum cotton and the various pyroxylines, from which collodion is made by solution in alcohol and ether. Celluloid consists of a mixture of pyroxyline and camphor, and was first prepared by Hyatt, of Newark. Artificial tortoise shell is made by welding plates of differently tinted celluloids.

Sulphuric acid acting on unsized paper produces vegetable parchment, etc.

Mercerization is produced by the action of alkalies on cotton cellulose, and when cotton cloth is thus treated the fibers are contracted 20 per cent., with an increase of 30 to 35 per cent. in strength, and an increased affinity for certain dyes.

A recent product is cellulose thiocarbonate, a substance which promises to rival celluloid in importance, as it has not the inflammability of celluloid; and to take the place of ebonite for purposes where the brittleness of the latter is a disadvantage. It is produced by the action of carbon bisulphide on mercerized cotton, or by bringing together two parts of cellulose, one of caustic soda, two of the bisulphide, and eight of water. By varying the proportion of the constituents a series of valuable products are obtainable, one resembling the softer varieties of india-rubber and another practically indistinguishable from horn, being hard, tough and perfectly adapted for turning. It is readily colored. The writer of the article quoted considers the importance of this new discovery to be manifest, especially in view of the failing supplies of ivory, for which it, like celluloid, is a substitute.

Carbon Blacks from Natural Gas.

AN industry peculiar to America, and one of considerable importance, is that of the manufacture of black from natural gas. A very thorough account of its history and the methods employed has been given by Mr. G. L. Cabot, of Boston, to the Scotch section of the Society of Chemical Industry and appears in its *Journal*, and has been reprinted in the *Scientific American Supplement*. The substance thus obtained has many trade names, as "carbon black," "hydro-carbon black," "gas black," "satin gloss black," "jet black," etc. It is quite different in quality from lampblacks made from oily or resinous substances, and also from the blacks once made on a small scale from ordinary illuminating gas. As Mr. Cabot says, the merit of the invention of these blacks, as with so many important discoveries, belongs to no one person, but must be divided among many. However, the first successful factory for making blacks from natural gas was built at Cumberland, Pa., in 1872, and was soon followed by many others seeking to utilize the natural gas then going to waste in enormous quantities and regarded as a nuisance by the petroleum men.

The original process employed a series of flat cast-iron pans filled with water, which was thought to improve the quantity and quality of the product. Under the pans were lines of common gas tips, the flame from which impinged on the iron and deposited the soot. At intervals a car provided with a scraper was drawn under the rows of pans, collecting the black. Of all the later factories, it is said that none have produced more black per thousand feet of gas or of softer quality; but important mechanical improvements were rapidly evolved. Water cooling was abandoned as an unnecessary complication; the pans were replaced by plain plates, also by concave plates. Various systems of collecting the black on revolving rollers with stationary scrapers; on revolving disks, up to 24 feet in diameter, either solid or with ventilating holes, with stationary burners and scrapers; on smaller rings similarly arranged; and on stationary plates with moving burners, scrapers and collectors, in great variety, were patented and introduced. In modern plants the product is handled entirely by machinery; is removed from the chamber by screw propellers, sifted and bolted, elevated into bins, and packed mechanically. The product is so light (5 lbs. per cubic foot) that it has to be compressed, and the plungers of the presses, after much difficulty from leakage in attempting to expel the air, are now faced with sheep pelts, which detain the black but allow the air to pass.

The first lots brought $2.50 per pound, but the price rapidly fell until in 1883 it reached 24 cents; later 8, 5, and even 3 cents were the net returns to the manufacturer, but recently the price has improved. The annual product has increased until, for 1894, it is estimated at 3,000,000 pounds.

The chemical composition of carbon black is about 92 to 93 per cent. carbon, 5 to 6 per cent. oxygen, and 1 per cent. hydrogen, with no trace of mineral matter. To the credit of the trade, Mr. Cabot affirms that no adulteration has been found.

Carbon blacks are used for printer's ink, paints, "mineral black," stove polish, shoe leather, rubber goods, coloring cement and mortar, artificial stone, stencilling, mixing with other blacks to improve them. The author makes comparisons between carbon blacks from gas and ordinary lampblack.

In a note on the foregoing paper Mr. Robert Irvine describes the older attempts to make blacks from illuminating gas, considers the proposition to make blacks from oil shale impracticable, and furnishes additional data.

Monazite.

UNTIL quite recently this peculiar mineral has deserved its name, the "lonely" or "solitary" mineral, having been found only in very small quantities in such widely separated localities as Finland and Cornwall, Norway and Bohemia. The New York *Sun* and the Boston *Jonrnal of Commerce* announce the recent discovery of comparatively large quantities in North Carolina, where a brown sand unfamiliar to the miners was met with in the placers. A sample was sent to a German analytical chemist, who pronounced the mineral monazite. Its most striking characteristic is its extreme refractoriness. An illuminating company happened at the time to be in need of just such a material, and hearing of the discovery sent experts to North Carolina to investigate, who found it "by the ton." It occurs along the river banks and in the river beds, in the clefts of rocks and in gullies, but it took large quantities of the crude material to furnish it in the shape required. Purchases for shipment to Germany were made at a price of from $150 to $200 a ton. This induced further search, and it is reported to have been discovered in eight counties of the State, where there is now a monazite boom, according to our authority.

Products of Combustion from Argand and Welsbach Burners.

THE results of researches on the chemical composition and sanitary effects of the products of combustion of coal gas as yielded by Argand and Welsbach burners have been communicated by M. N. Grehaut to the *Comtes Rendus*, and the note has been translated for the *Chemical News* and again appears in the *American Manufacturer*. The author first describes his apparatus and method and their verification, and then gives his results. He finds that in the products of combustion from the Argand burner there exists (besides carbon dioxide) a trace of gas containing carbon, but the proportion is so slight that it may be estimated at 1-15,000, carbon monoxide (the poisonous gas) being absent. With the Welsbach burner, which gives so white and dazzling a light, the case is different. Formene or carbon monoxide, or a mixture of both, were found in the products of combustion to the amount of 1–2580. In the former instance physiological tests showed no carbon monoxide present; in the latter a decided result was obtained. The author's conclusion is that "from a sanitary point of view it is very important to allow the products of the combustion of coal gas to escape into the open air, especially if derived from the Welsbach burner."

Manufacture of Sulphuric Acid.

A VERY complete, though necessarily condensed, summary of the history of the sulphuric-acid manufacture from its inception in 1746 down to the present is given by the *Revue Technique*, concluding with a description of the new Barbier process. The article has been translated for the *Scientific American Supplement*. Full details of the operation of this process and an illustration of the apparatus are presented. It is claimed that the arrangement, under a simple and practical form, realizes the long-sought problem of the manufacture of sulphuric acid without lead chambers.

The plant consists of pyrites furnaces and three small reaction towers, interposed between a sort of Glover or denitrating tower and a Gay Lussac tower of peculiar construction. These various towers are filled with small cells with perforated bottoms, that present from 70 to 75 square meters of friction surface per cubic meter of filling. Beneath the towers, and in communication with them, are arranged basins in ascending series which are heated directly by the hot gases from the roasting furnaces. These basins receive on the one hand the dilute sulphuric acid and the nitric acid from the reaction towers, and on the other the nitrous-sulphuric acid from the Gay Lussac tower.

It is stated that the cost of producing acid does not exceed that of the acid made in lead chambers, and that it is even less when the interest on the small capital invested is taken into account. Also that the apparatus has great simplicity of installation and operation. It is applicable to a daily production varying, according to dimensions of towers and number of roasting furnaces, from 1400 to 20,000 pounds or more of acid.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

25799. On the Preparation of Carbon Blacks from Natural Gas in America. Godfrey L. Cabot (Sc A S–Oct. 13.) 3400 w.

25800. The Lardarelo Boric Acid Works. (Sc A S–Oct. 13.) 700 w.

*25873. The Electrolytic Production of Chlorine and Soda. Emile Andreoli (E R L–Oct. 5.) 1200 w.

25891. Sodium Silicate and Its Use for Cleansing Cotton Waste, etc. (T–Oct. 15.) 1400 w.

25991. On the Presence in Paper of Residual Chemicals Used in Its Preparation. Robert Irvine and G. Sims Woodhead. (Sc A S-Oct. 20.) 2000 w.

26199. Cellulose and Some of Its More Recent Applications. Charles A. Silberrad (Sc A–Oct. 27.) 1700 w.

26201. The Chemical Pulp Process (Sc A S–Oct. 27.) 1200 w.

†26229. A Method for Determining Calcium Oxide in Quicklime. W. E. Stone and F. C. Scheuch (J A C S–Nov.) 1500 w.

26350. Economic Manufacture of Sulphuric Acid. Ill. (Sc A S–Nov. 3.) 2500 w.

26351. Utilization of Waste Carbonic Acid Gas in Breweries. A. Marcet (Sc A S–Nov. 3.) 1200 w.

†26379. I. On Some New Methods of Obtaining Platinochlorides. II. Probable Existence of a Platinum Subchloride. M. Carey Lea (A J S–Nov.) 1500 w.

26456. Petroleum: Its Products and Their Relation to the Gas Industry. C. H. Evans (A G L J–Nov. 5.) 2200 w.

26473. Monazite.—A Strange Mineral Found in North Carolina (B J C–Nov. 3.) 400 w.

26495. Weathering. William White, Jr. (A M & I W–Nov. 2.) 600 w.

*26498. Chemistry of Iron: Modern Practice. John Parry (I & S–Oct. 27.) 3300 w.

We supply copies of these articles. See introductory.

INDUSTRIAL SOCIOLOGY

Workmen's Diet and Wages.

THE subject named is one of unquestionable importance, and in the *Fortnightly Review* it has been treated from a physiological as well as sociological stand-point, by Thomas Oliver, M. D., who shows by a comparison of the dietaries of former periods and of the present that the toiling classes of Britain have shared in the advance that has been made in the feeding, clothing, and housing of the nation generally. No attempt is apparently made to show that artisans or agricultural laborers have fully and fairly shared in this advance. The main point considered is their diet. The "diminished use of simpler foods and the increased consumption of articles which tickle the palate more than did the plain but wholesome food of our forefathers" is noted. "The tendency of the age is toward refinement in food as in all else. We seek for articles that please the eye, as well as stimulate the palate. People, for example, must have their flour beautifully white; but in order to accomplish this the miller has, by improved machinery, to remove from the grains of wheat the rich nitrogenous cells that lie underneath the bran—that part of the wheat grains in fact which is richest in proteid or nitrogenous material." This is instanced as indicating a widespread change in regard to alimentation of the laboring classes which is in progress in Britain. Tea has been reduced in price, and in the cottar's home "tea with bread and butter, now too frequently replaces the milk and often porridge of past days." The words "too frequently" must be taken as applying to the physiological view of the subject, its economic side, except so far as food is related to muscle and muscular effort represented in useful labor, having been left out of view.

It is asserted that shepherds and hinds in many parts of England are paid less "in kind" than they were; that they therefore have more money to spend; that money has a greater purchasing power than formerly, and that little delicacies and luxuries are now more sought after. This is all the more true of artisans dwelling in cities. Among these a distinct tendency toward "a reduction of coarse food, and a substitution for it of the higher, if not less nutritious articles of diet," is perceptible.

The collection of materials for the purpose of study and comparison of the present dietaries of different parts of the kingdom has been largely effected by correspondence, and much interesting information has been thus got together.

"From his well stocked garden the Scottish agricultural laborer obtains potatoes, green vegetables and fruit. Many of them get their milk either free or at a nominal cost from the farm. Their breakfast is milk and porridge. For dinner they have broth, meat, potatoes, and tea. At 6 P. M. they have porridge and milk, bread and butter, and jam." The cost of living per week in a family the father of which gets 15 shillings per week and the allowances named, and which consists, beside the father, of a wife and five children, is stated to be from 12 to 13 shillings per week, the remainder being required for clothing, etc. "The cottar, practically, can make no provision whatever for sickness or death, unless in a few cases only, where he pays a penny or twopence a week into a burial society. It is when his children grow up and enter service, that he may be able to save a little money."

The wages of Irish agricultural laborers are smaller and their dietary more meager than that of Scottish laborers of the same class. Wages, 5 to 8 shillings per week. So insufficient is his feeding, that when the Irish farm laborer goes to England to work in the harvest, it is not until two or three weeks of more ample diet strengthen him that he can do a full day's work. "Potatoes are still the staple diet of the Irish peasant." This food is extremely deficient in nitrogen. Many Irish laborers live upon Indian meal mixed with white flour, potatoes, and tea, seldom partaking of animal food.

"When the English agricultural laborer has no children he is able to feed pretty well. He consumes large quantities of fat. He eats largely of bread and cheese. When he has a family it costs him 67 per cent. of his wages for the necessaries of life and house rent. Coal miners are said to feed well, using considerable animal food; and the dietary of the English navvy may compare well with that of the collier. Iron and steel workers work hard, get good wages and substantial food, and the temperate can save something out of their wages." The women who work in the manufactories of white lead are spoken of as about the worst fed laborers in England, their diet being reduced by their necessities almost to the starvation point. In every point of view, their condition is pitiable. Their poorly nourished bodies are ill fitted to resist the poisonous action of the lead, to which many of them fall victims.

While the cotton spinners of Lancashire are stated to be as a class well paid and well fed, they are as a rule not in robust health. In some of the factories where fine spinning is done the air has to be kept too warm and moist for health; and in general the work of cotton spinning is carried on in large, frequently overheated, and at times not too well ventilated rooms. Cotton spinners leave their homes in the early morning, both husband and wife usually working in the same factory. If they have an infant, it is left at a creche, and as "many of them take their food to the mill, it is not until the day's labor is over that the mother picks up her child on the way home, opens the house, kindles the fire and prepares tea." The rent of their house is from 4*s*. to 4*s*. 6*d*. per week. They work 56½ hours per week. Wages not named. Nervous diseases are on the increase among them, especially insanity. Child-bearing is fatal to many of the women. "Standing on their feet all day amid the roar and din of machinery, inhaling an atmosphere overheated, humid, laden with fluff, and redolent with rancid oil, their life's work in time becomes as mechanical as the machinery they tend, and their prospects as cheerless as their work is monotonous."

At Nottingham lace workers labor ten hours a day, and earn 40*s*. a week. Girls earn from 6 to 15*s*. Rents range from 4*s*. 9*d* to 6*s* 3*d*. Except when daughters work they save no money. Their diet is fairly good. Men employed in woolen industries in and around Bradford live pretty well. They work from 10 to 10½ hours per day, earn from 18 to 32*s*. per week, and their house rent ranges from 3*s*. to 4*s*. 6*d*. per week. They are temperate, and saving.

Thus is seen how many of the workers of Great Britain live, what they earn, and what they pay for rents. The question of the effect of diet as related to physical ability to labor is discussed, as are also the questions of wages as related to food, and the best selection of food within the scope of wages which British labor commands.

The Legislation of Fear.

SINCE time and distance, through the aid of steam and electricity, have ceased to be materially obstructive to intercourse between the continents the unity of the human family, notwithstanding national boundaries and race prejudices, is daily increasing. A czar or a great statesman falls sick in almost any part of the world, and we hear daily accounts of his condition as surely, and almost as quickly as we would were he a neighbor citizen living in the next block. If he die we shall have the news in an hour or two. Puck's forty-minute girdle has been stolen by science from the fairies, and the common pulse of humanity beats in unison on opposite sides of the seas. When any voice that has won the right to be heard is now raised in behalf of the oppressed it is heeded almost simultaneously over both hemispheres. When any pen whose power has been proved is wielded on the side of right, it commands not merely a local, limited influence; the field is the civilized world. Among those to whom the world gives such attention is a woman who first won fame as a novelist, and having proved by her powerful delineations of human passion her keen insight into the springs of human action—having probed to their depths the virtues and vices of existing social conditions—has lately taken place among essayists.

This woman, Ouida, always writes with force. It can hardly be claimed that her advent into this field has added much to the thought pervading current sociological discussion ; but it cannot be denied that it has added to the interest of the debate.

In the *Fortnightly Review* (October) in "The Legislation of Fear," she has fearlessly made some startling statements which those who wish to keep in touch with what is going on will feel obliged to read if they do not want to move rearward in the procession. The contention is characteristically set forth in the opening paragraph. Ouida does not leave her readers long in doubt of what she is driving at :

"To any one convinced of what seems to be a supreme truth, that the happiness of humanity can only be secured by the liberty of the individual, the tendency of opinion in Europe in this present year must be a matter of grave anxiety. The liberty of the public is everywhere suffering from the return to reaction of their governments. The excesses of a few are made the excuse for the annoyance and restriction of the many. Legislation by fear is everywhere replacing legislation by justice, and is likely to continue to do so. The only statesman who has spoken of anarchy in any kind of philosophic spirit is Lord Rosebery, who called it 'that strange sect of which we know so little.' All other political speakers have treated it only with blind abuse. In truth we do know almost nothing of it ; we do not know even who are its high priests and guiding spirits. We know that it is a secret society, and we know that secret societies have always had, in all climes and for all races, the most singular and irresistible fascination. To meet it ordinary society has only its stupid brutal police system ; its armies of spies, who as the journey of Casserio from Cette to Lyons proves, are hopelessly useless, even when they are truthful."

That "Legislation by fear is everywhere replacing legislation by justice," is made plausible, if not proved by a long array of facts, and incidentally a comparison between anarchism and nihilism is made which is favorable to the latter :

"It is impossible not to recognize great qualities allied to great cruelties in anarchists and nihilists, and, in the former, to great follies. When we remember the ghastly punishment of even the slightest offences in Russia, yet see continually that some one is found who dares place on the Tsar's dressing table or writing table a skull, a threatening letter, a dagger, or some other emblem and menace of death ; that to do this access is obtained into the most private and carefully guarded apartments of imperial palaces ; that who it is that does this can never be ascertained (*i. e.*, there is no traitor who betrays the secret), and that the most elaborate vigilance which terror can devise and absolutism can command is impotent to trace the manner in which entrance is effected, we must admit that no common organization can be at work, and that no common qualities must exist in those affiliated to it. There is no doubt that anarchism is a much more vulgar and much more guilty creed than nihilism. The latter has the reason of its being in the most brutal government that the world holds ; it lives in hell and only strives to escape from that hell, and liberate from it its fellows. Anarchy, with no such excuse, strikes alike at the good and the bad ; strikes indeed at the good by preference."

The array of facts that follow, compiled from recent annals, indicate the trend of public opinion in Europe as away from individual liberty. A few of those most briefly stated will be quoted.

"A youth of twenty-one was in the second week of July condemned at Florence to fifteen months' imprisonment for having called the *pretore* of a petty court and his subordinate *vigliachi* (scoundrels) ; an expression so appropriate to the officials of these vicious and corrupt little tribunals that it was unpardonable. If at the end of the fifteen months the lad comes out of prison at war with society, a second Caserio, a second Vaillant, whose will be the fault ?

"A young lady of good family saved a little dog from the guards in Paris and when she had seen it safely up its staircase turned in righteous indignation on the men. 'Are you not ashamed to persecute innocent little animals?' she said to them. 'You would be better employed in catching thieves.' This just remark so infuriated them, as a similar observation did the Florentine *pretore*, that they seized her, cuffed her, dragged her along under repeated blows, tearing some of her clothes off her back, and, reaching the police station, locked her up with the low riff-raff of the streets.

"In July at Ravenna eight young lads were flung into prison for singing the Hymn of labor.

"Yet more absurd still. In Florence a band of young men were arrested for singing the choruses from the *Prophete*, which sounded revolutionary to the ears of the police. At the same time, the indulgence shown to the crimes of the police is boundless."

A glowing tribute is paid to the late President of France.

"Carnot lies dead in the Pantheon, and Liberty lies dying in the world. His tender and unselfish heart would have ached with an impersonal sorrow, greater even than his grief for those he loved, could he have known that his death would have been made an excuse for intemperate authority and pusillanimous power to gag the lips and chain the strength of nations."

This essay appeals perhaps more to heart than to reason, but it appeals to reason also; and as to its allegations of police brutality, some American cities, New York in particular, will be prepared to believe almost anything.

Possibilities of an Anglo-American Re-Union.

A SYMPOSIUM upon this subject appears in the *North American Review* for November. Capt. Alfred T. Mahan, U. S. N., and Capt. Lord Charles Beresford, R. N., both give opinions unfavorable to the practicability of an alliance at the present time as has been proposed.

Capt. Mahan opens the discussion by making a distinction between the words "kinship" and "alliance." "The former represents a natural relation, the latter one purely conventional—even though it may result from the feelings, mutual interests, and the sense of duty attendant upon the other. In its very etymology, accordingly is found implied a sense of restraint, of an artificial bond, that may prove a source not only of strength, but of irksomeness as well. Its analogue is the marriage tie—the strongest doubtless of all bonds, when it realizes in the particular case the supreme affection of which our human nature is capable; but likewise, as daily experience shows, the most fretting when, through original mistake or unworthy motive, love fails, and obligation alone remains."

The growth of mutual kindly feelings between Great Britain and the United States during these latter years is regarded as "a sure evidence that a common tongue and common descent are making themselves felt, and breaking down barriers of estrangement which have too long separated men of the same blood."

The geographical position of the two countries which so severs them from existing rivals as to give exemption from "the burden of great land armies" is a condition favorable to the ultimate reunion.

"To Great Britain and the United States, if they rightly estimate the part they may play in the great drama of human progress, is intrusted a maritime interest, in the broadest sense of the word, which demands, as one of the conditions of its exercise and its safety the organized force adequate to control the general course of events at sea; to maintain, if necessity arise, not arbitrarily, but as those in whom interest and power alike justify the claim to do so, the laws that shall regulate maritime warfare. With such strong determining conditions combining to converge the two nations into the same highway, and with the visible dawn of the day when this impulse begins to find expression in act, the question naturally arises: What should be the immediate course to be favored by those who hail the growing light, and would gladly hasten the perfect day?" And it is here that an obstacle presents itself in the lack of experience which cannot be had in advance of facts not yet developed. "Let each nation be educated to realize the length and breadth of its own interest in the sea; when that is done the identity of those interests will become apparent."

This development will "follow the not far distant day when the United States people must again betake themselves to the sea, and to external action as did their forefathers alike in their old home and in the new."

Capt. Mahan thinks that however desirable it may appear, such an alliance could not be effected at the present time. The requisite conditions for cordial agreement do not yet exist.

"Is it not clear that maritime commerce occupies, to the power of a maritime state, the precise nourishing function that the communications of an army supply to the army? Blows at commerce are blows at the communications of the state; they intercept its nourishment, they starve its life, they cut the roots of its power, the sinews of its war. While war remains a factor, a sad but inevitable factor, of our history, it is a fond hope that commerce can be exempt from its operations, because in very truth blows against it are the most deadly that can be struck, nor is there any other among the proposed uses of a navy, as for instance the bombardment of seaport towns, which is not at once more cruel and less scientific. Blockade, such as that enforced by the United States Navy during the civil war, is evidently only a special phase of commerce-destroying; yet how immense—nay, decisive—its results."

Lord Beresford quotes Mr. Carnegie (*North Am. Review*, June, '93) and agrees with the following contentions in support of an alliance: "1. The natural sympathy and brotherhood between two nations sprung from one race. 2. The quick, comfortable, and efficient line of communication between the two countries. 3. The excellence of the telegraphic communication. 4. The easy possibility of confederation between two races similar in character, ideas, and sentiments." But the suggestion of "alteration in the fiscal policy of the two countries" made by Mr. Carnegie is pronounced "a complete impossibility." Neither does Lord Beresford agree with a statement made by Mr. Carnegie "that the individual parts of the empire hail such a union with enthusiasm."

"The United Kingdom must be spoken of as a whole, and it is impossible to talk of England, Ireland, Scotland, and Wales as semi-independent states. The United Kingdom must remain a whole, if it is to remain at all. If split up it could not retain that force and character which have enabled it to build up and govern the greatest empire the world has ever seen." The different impediments to a reunion as enumerated by Mr. Carnegie are gone over seriatim. Finally Lord Beresford makes a suggestion claimed to be more practical than those hitherto presented, to wit: "An alliance between Great Britain and the United States for the protection of those commercial properties in which both are equally interested."

"What is coming in the near future, who can tell? But will anybody deny that an alliance such as is advocated here would do much to insure the continued peace and prosperity, not only of the Anglo-Saxon race, but of the entire civilized world?"

A Proposed Series of International Expositions.

An attempt now on foot to draw the nations of the western hemisphere into closer communication and more intimate commercial relations is gaining favor and assistance from those it is intended to benefit—such as are engaged in or who desire to extend American commerce in Central and South America. A scheme for a series of international expositions to be held in South American capitals (the first to be held in the City of Mexico) proposed by *Dixie*, a journal devoted to the industrial interests of the South, has received marked encouragement from manufacturers in different parts of the

United States. A letter written by Mr. T. P. Egan, a widely known and influential western manufacturer, and printed in the Cincinnati *Commercial Gazette*, indicates the spirit with which this proposition has been received. An initial movement has been made to hold a convention of manufacturers to consider the subject, and to take action toward carrying out *Dixie's* proposal. Mr. Egan's letter is an argument favoring first, the holding of the expositions, and secondly, favoring Cincinnati as the place for holding the convention.

" The severe conditions under which our manufacturers have labored for the past twelve months would have been lightened to a considerable extent had they in the past taken the pains that European manufacturers have taken to establish trade relations with Mexico, Central and South America. The Europeans have devoted every energy to ingratiate themselves with the buyers in these countries, while our manufacturers have been satisfied with very indifferent efforts.

"The J. A. Fay & Egan Company, The Lodge & Davis Machine Tool Company and several others of the leading manufacturers of this city have been sending Spanish-speaking representatives for the past three years to these countries. They have invariably secured large and remunerative orders, proving conclusively that the business is there and can be obtained.

" It is true that the rapid development of our own country has heretofore called for nearly the entire output of our manufacturing establishments, but the recent past, and in fact the present condition of the machinery trade, prove that our foundries and machine shops have a greater capacity than domestic consumption demands, and our manufacturers are on an active outlook for new trade fields. It has not been a lack of enterprise, but a lack of necessity, that has until now deterred their efforts to win the trade of our sister Republics.

" European machinery and equipment of a very inferior grade is being sold in large quantities to the miners, manufacturers and developers of the Spanish-American Republics. Europeans are getting good prices for this machinery, prices that our manufacturers would jump at ; but as matters stand, we have no means of getting at this trade."

The proposition made by *Dixie*, comprised the restoration of reciprocity treaties rescinded by the last congress, as very little business can be done unless these treaties are restored. " The plan upon which these expositions could be held to mutual advantage would be that the government of these different countries would make an elaborate display of their mineral and other resources, together with a complete exhibit of all interesting features of their country, the manufacturers of the United States to coöperate with the different governments by making a magnificent display of machinery and other manufactured products adaptable to the needs of the different countries."

It seems possible that the convention will be held at an early day, and Cincinnati seems a favorable point to hold it, being centrally situated in a large manufacturing district, which can be easily reached not only by southern delegates, but from all parts of the country. The movement is growing in importance, and its issue will be watched for with interest on both sides of the Atlantic.

Labor Misrepresentations.

Of " Popular and Injurious Class and Labor Misrepresentations," or what he is pleased to characterize as such, an anonymous writer in *The Westminster Review*, has something to say in the October number. A defense is made of the " wealthy and upper classes " from the charge that they are " selfish robbers whose luxuries have been obtained by defrauding the poor." The custom of holding up the improvements achieved, " as rights acquired solely by force of organizations of the workers against their employers " is denounced as not warranted by facts. If it be justified, then, obviously, " the employers must previously have peen oppressing their men for their (the men's) own benefit, and amassing wealth which is now divided amongst the men. " How far is this the real explanation of the admitted very great change for the better in their condition?"

Under conditions existing a century ago, low wages prevailed, "but low wages to hand labor would not result in cheap buildings or goods." Small buildings must have cost proportionally very much more than the better houses of to-day." Clothing woven by hand could only be relatively dear and scarce." "Food has been cheapened during the same period by the construction of railways and steamboats, and the invention of the telegraph and telephone, which enable practically limitless supplies to be brought from the ends of the earth to counteract scarcity in any quarter."

While this is true, it is also true that wages have been augmented—in many cases doubled—while hours of labor have been reduced. How then has labor been robbed? And who are the robbers, if any exist? The proposition is rejected as absurd, and this kind of talk is denounced as having no reasonable basis, and as therefore hurtful to the cause of labor.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25570. Profit Sharing in the Coal and Iron Industries. Editorial (I C T–Sept. 21.) 1600 w.

25590. The Liability of Labor Unions for Damages—The Lucke Case. R. W. Raymond (E M J–Sept. 29.) 500 w.

25591. Bimetallism vs. Silver Monometallism (E M J–Sept. 29.) 1500 w.

25618. Governor McKinley Compares the New and the Old Tariff Laws (B I S–Oct. 3.) 1500 w.

*25758. The Social Improvement of European Labor.—Laudable Efforts of Continental Employers. E. R. L. Gould (E Mag–Dec.) 3500 w.

25811. The Jenkins Strike Injunction Case (R R–Oct. 6.) 4800 w.

25814. Theory and Practice. Editorial (R R–Oct. 6.) 1100 w.

†25824. Popular and Injurious Class and Labor Misrepresentations (W R–Oct.) 2500 w.

25903. A Remedy for Railway Strikes. Robert Larmour (R R–Oct. 13.) 2200 w.

†25963. The Work of the Beer Money. John Rae (C R–Oct.) 12000 w.

†25964. French Prisons and Their Inmates. Edmund R. Spearman (C R–Oct.) 6000 w.

†25974. Our Workmen's Diet and Wages. Thomas Oliver (F R–Oct.) 6400 w.

25981. Compulsory Arbitration and Prices Fixed by Law. (Extract.) Carroll D. Wright (Ir Age–Oct. 18.) 900 w.

26147. The Arbitration Question (B D–Oct. 20.) 900 w.

*26161. Labor vs. Machinery (M–Oct. 15.) 1400 w.

*26210. The Recent Strike at Pullman. Editorial (E–Oct. 19.) 2700 w.

†26263. Possibilities of an Anglo-American Reunion. I. Alfred T. Mahan. II. Charles Beresford (N A R–Nov.) 9000 w.

†26268. The Legislation of Fear. Ouida (F R–Oct.) 4500 w.

*26281. Guilds and Unions in the Middle Ages (I C B–Oct. 19.) 2500 w.

26290 Marketing the Surplus. Editorial (E M J–Oct. 27.) 1000 w.

26303. Extracts from the Address of Thomas B. Reed at Cooper Union (B I S–Oct. 27.) 2000 w.

26315. American Manufacturers.—Cincinnati the Place for the Forthcoming Convention of a Great Industry. T. P. Egan (C C G–Oct. 16.) 600 w.

*26324. The Wage Earners' Loss During the Depression. Samuel W. Dike (F–Nov.) 4800 w.

*26325. Facts Touching a Revival of Business (F–Nov.) 2800 w.

26344. The Institute of Sociology (ScA–Nov. 3.) 800 w.

26387. Convicts on the Public Roads. Views of Governor Northen (M R–Nov. 2.) 1000 w.

26388. Greater Trade with Mexico (M R–Nov. 2.) 1300 w.

26423.—$1. The Economic Function of Woman. E. T. Devine (An A A–Nov.) 5400 w.

*26431. Labor Saving Machinery (Mill-Oct.) 1300 w.

*26440. Machinery and Labor. Editorial (E–Oct. 26.) 1800 w.

*26441. The Scotch Coal-Miners' Strike. Editorial (E–Oct. 20.) 1800 w.

*26508. Labor Troubles at the Plymouth Gas-Works.—Attempts to Wreck Plant (J G L–Oct. 23.) 1600 w.

†26532. Immigration and the Land Question. C. J. Buell (A–Nov.) 3300 w.

26619. The Foreign Trade of Japan and the Nicaragua Canal (M R–Nov. 9.) 1500 w.

MARINE ENGINEERING

An Aluminum Torpedo Boat.

"TEN tons with steam up and coal in the bunkers; twenty and a half knots speed; 300-horse-power." *The Engineer* (London, Oct. 5) says that "ten years ago—perhaps five years ago—the man who suggested the possibility of producing a boat which could live in a sea and satisfy the conditions embodied in the first lines above, would have been regarded as a lunatic by those who had not watched the progress of events." On September 30, on the Thames river all these conditions were fulfilled by Mr. Yarrow in an aluminum torpedo boat, the largest structure of any kind yet built of that metal. Two other aluminum boats have been previously built, one for use in arctic exploration and a small yacht. A description with an illustration of the new torpedo boat informs us that she is 60 feet long, and 9 feet 3 inches beam. Her width of beam—9 inches more than other second-class torpedo boats that have preceded her, is considered as an "improvement in many respects." It appears that for this and analogous purposes in marine engineering a new field has been opened for the use of aluminum, which may have an important influence upon the future of this metal in the industries of the world. The lighter anything which has to be hoisted to or lowered from the deck of a ship can be made, the better it is, provided no other useful quality be sacrificed, and the lighter a ship's boat for any purpose can be made, all other things being equal, the higher the speed that can be attained with it. English battle-ships carry as part of their regular equipment a number of these boats; and if it prove that aluminum is fitted in all respects as a material for their construction, a third advantage gained in the reduction of weight thus secured (as these boats are carried high up on deck) is that they will affect the stability of the ship less than heavier boats.

"Comparatively little has been known about aluminum as a structural material, and before adopting it Messrs. Yarrow and Co. carried out a series of elaborate experiments on the metal to obtain information. The great and uniform success of this firm in all their ventures is largely due to the elaborate system of experimenting carried out at Poplar. The trials of aluminum referred to its stiffness, best working temperature, corrosion, etc. It was found, in the first place, necessary to alloy the metal, by which its tensile strength was raised from 9 tons per square inch to about 18 tons. The alloy is mainly 6 per cent. of copper. As regards stiffness, etc., a general result was arrived at. All scantlings were increased 25 per cent. over that allowed for steel, and as aluminum weighs about one-third of steel, it follows that a reduction of about one-half was effected in the weight of the hull, which was reduced from about four tons for steel to about two tons for aluminum.

"In order to arrive at some precise information concerning corrosion, two aluminum plates were accurately weighed, and then secured on the sides of a wooden coppered sailing ship, the copper being removed and replaced by the aluminum. The ship made a voyage around the world, then the aluminum plates were removed, weighed, and found to have suffered no appreciable loss. The great foes to aluminum are alkalies which attack it powerfully, and heat. It fuses at a moderate heat, and loses much of its strength at comparatively low temperatures. In the case of a torpedo boat there is no trouble incurred in avoiding both sources of risk. No plates or angles were touched by the fire; everything was bent cold. The frames are a little closer together than they would be if of steel, the extra cost of material in the use of this particular boat being £1000 as compared with that of steel. In turn there is a saving of about two tons in weight and a gain of about

3½ knots in speed over vessels of the same class and dimensions in the British navy which steam under the like conditions at 17 knots.

"The boat is built in the usual way and triple-riveted with aluminum rivets. Her machinery consists of a set of triple-expansion engines, driving an aluminum bronze propeller at 580 to 600 revolutions per minute. These engines are balanced without bob weights, on Mr. Yarrow's principle, at two points only, the balance weights being fitted at properly calculated angles to the cranks. The boiler is of the ordinary Yarrow water-tube type."

After presenting the record of the official trial of the boat, *The Engineer* hazards the opinion that this boat is in every way a marked success. If further experience sustain this view a good many aluminum boats of various kinds will probably be built during the next decade.

"Beyond all question Mr. Yarrow has achieved a remarkable success. Many wise men shook their heads when he suggested the use of aluminum, and did not hesitate to say he was courting failure. The result, however, has more than justified him; he has succeeded in producing the best torpedo boat of the size that has ever been built. It now remains for the makers of aluminum to improve their processes and cheapen their material, so that the use of the new metal may be widely extended."

A New South African Liner.

FEW Americans have the slightest idea of the kind and amount of traffic now existing between English ports and the South African colonies. A description of the new South African liner *Norman* given in *Transport* (Oct. 19), will afford a more realizing impression of the tendencies of this traffic than would otherwise be obtained except by those who have had opportunity for personal observation.

"The leading dimensions of the vessel are: Length 490 feet between perpendiculars; breadth, molded, 53 feet; depth, 37 feet 6 inches; and her gross tonnage is 7392 tons. She is constructed of steel, and is fitted with twin screws like five others of the Union Company's fleet. This arrangement will contribute much to the safety of passengers, as in the case of one set of engines becoming disabled, the other set of engines will still be able to maintain a fair speed and propel the ship on her voyage. She is fitted with two sets of triple expansion engines, expected to develop great power and high speed, and at the same time she is designed for carrying a large cargo, or considerable numbers of troops. Large numbers of passengers are provided for in each class. The first and second-class accommodation is amidships, thus insuring comfort, quiet, and ample ventilation, the third class being located on the main deck forward; and in this connection it may be mentioned that the *Norman* is capable of berthing 160 third-class passengers surrounding their saloon; but if there should be a greater number offering at any time, equally good quarters can be provided for them.

"The first-class saloon provides seating accommodations for 150 passengers, and is situated on the upper deck. The panelling has been carried out in wainscot oak, tastefully carved and relieved in gold. The apartment is surmounted with a magnificent dome, consisting of a semi-circular vault terminated by hemispherical ends filled with stained glass, into the design of which shells and marine vegetation enter largely, and containing symbolical representations of agriculture, commerce, manufactures, painting, sculpture, and letters, the whole forming a very carefully considered decorative scheme. The second-class saloon is situated on the main deck aft, and furnishes seating accommodations for 100 persons. The drawing-room and library, which is placed at the forward end of the deck-house on the promenade deck, is about 36 feet long by 24 feet broad, and upwards of 10 feet in height. The general decoration is carried out in elaborately designed satin-wood panels. The smoking rooms, both for first and second-class passengers, are very luxurious. The *Norman* is constructed with poop and forecastle, and has central deck-houses containing dining-saloons, etc., over which is an exceptionally fine promenade deck. Electric light and refrigerating plant has been installed throughout, and there are refrigerating engines and machinery. Cold chambers are provided for ship's stores, as well as for the conveyance of fruit and other perishable goods. The vessel is divided into water-tight compartments in accordance with the recommendations of the parliamentary bulkhead committee, thus insuring the maximum safety of passengers in case of accident."

It must be understood that this fine steamship is only one of a magnificent fleet of the Union Steamship Co. which conveys a stream of civilization to and fro between England and a country that a century ago, was peopled by barbarians. The time set for the new ship to sail on her first voyage was the 10th Nov. She is to start on her return trip on the 19th Dec.

The British Shipbuilding Industry.

UPON returns recently issued from Lloyds Registry, *Engineering* (London) bases an editorial opinion that the shipbuilding industry has a depressing outlook for the coming winter. The work on hand in the ship-yards is less than at any previous time in the year, although the output up to the present time has been very much below the average. Neither are there visible any immediate cheering signs of a revival.

"There is scarcely any need to inquire into the reason, for it is notorious that the board of trade, at the bidding of the political agitator, has raised so many restrictions in respect of ships flying the Union Jack, as to immensely handicap them in their competition with foreign ships. In fact, the foreign flag is a protection to the ship against many pettifogging regulations which do real good to few, and injure a great industry. That they do little good is evidenced by the fact that foreign ships can easily get British crews, and that injury is done is proved by the large number of vessels sold to foreigners, the diminution in vessel building, and the large number of vessels building for foreigners in British yards. The proportion is usually a fourth to a fifth, even in times of activity in the yards, and at present nearly 15 per cent. are for foreigners, so that it may be accepted that the influences at work are not so strongly operative in the case of the foreigner. Low freights of course, have much to do with the matter, but, that, all things being equal, would affect foreign in the same ratio as British tonnage. They do not, because all things are not equal."

The falling off of work since the beginning of the year has been very marked, and since July 1, the decrease has been 65,000 tons. Counting from April 1, the falling off has been 72,000 tons. The steady diminution in the proportion of sailing tonnage to the total, is one of the notable features of the statistics of the trade. "The tonnage being started is only about half what it was in April, and as the total tonnage is very much less now than it was then, the state of the trade is very much worse than it was at the spring of the year." A table of the apportionment of the work among the various shipyards is given. Both colonial and foreign orders for ships, especially for sailing vessels are unprecedentedly light.

Naval Construction in France.

UNDER the title "The Decennial Programme for Naval Construction in France," *The Engineer* (London) discusses editorially the programme of construction set forth by the French admiralty board at the end of 1891, which included a list of 82 vessels, all of which were to be built before the expiration of the year 1901. The list of these vessels, showing their kind and class, is given. The cost of their construction is estimated as $145,200,000. The point made is that this programme, begun with apparent vigor, has been more and more departed from, and that it is even likely to be abandoned.

Once the decennial programme of 1891 was voted in parliament, the admiralty board deemed it necessary to begin in good time the eighty-two ships, in order that they might be completed at the end of the year 1901. Now, for the first three years—1892, 1893, and 1894—the number laid down should have amounted to 29, viz.: sea-going battleships, 6; first-class cruisers, sheathed, 2; unsheathed, 1; second-class cruisers, sheathed, 2; unsheathed, 4; third-class cruisers, sheathed, 4; unsheathed, 3; torpedo-depot ships, 2; floating workshops, 1; torpedo-gunboat, 1; gunboats, 3; total, 29.

A close review of what has been done during the time that has elapsed since its promulgation towards carrying out this programme is then presented, all the vessels begun in the different years being named, showing that year by year, beginning with the year 1891, the departure from the original scheme has been widening, and the statement is made that at the end of 1894, nine of the projected ships will not have materialized.

Sailing Vessels on the Hudson River.

THE gradual diminution in the number of sailing vessels on the Hudson river and the corresponding increase in the number of steam craft is made the subject of editorial comment in the *American Shipbuilder*. Only a few years ago steam craft except for passenger traffic, were the exceptions; now they rule, and the picturesque sight which the river once displayed with its multitudes of sails has probably forever departed. The time is recalled when the passenger traffic up and down the river was confined to packet sloops which were "beautifully modeled vessels of from 75 to 100 tons burden, built with a view to speed, carrying capacity and comfort. The sides of some were adorned with bead work and others with different colored woods inlaid. They were all handsomely painted. The canvas was snowy white and the masts were scraped as often as a speck of dirt appeared. The cabins were finished in mahogany and other fancy woods, and were decorated as beautifully as the taste of the times permitted."

Other interesting reminiscences are recalled. The colonists were compelled by law to use no other than the sloop brig. The reason assigned for this is jealousy of colonial enterprise on the part of the mother country, and an endeavor to restrict the colonist merchants to small coasting vessels, "but the American spirit kept the letter of the law by building nothing but sloops, while it captured the foreign trade by building them large and swift enough to compete with the best vessels constructed by Europeans. Afterward, when taxes were levied on colonial trade, the people were as anxious to conceal their true condition as the owners of personal property are in these days. Thus a report made by the Governor of Rhode Island to the Lords of the Committee of Colonies said that 'We have no shipping belonging to the colony, but only a few sloops.'"

When a custom house was established at Newport and the Lords of the Committee of Colonies made inquiries, they found that *few* meant over a hundred, and that "Rhode Island sloops could carry more cargo than British brigs." An anecdote is told of a "Hingham sloop of forty tons measurement which sailed out of Boston harbor bound for Canton. . . . The captain of the sloop did not know that the shortest route to the east lay one thousand miles south of the Cape of Good Hope. At Cape Town harbor where the captain put in for supplies, a number of English merchantmen were found. They thought it would never do to allow a Yankee to get a taste of the profitable East India trade, and bought the sloop's cargo, which consisted of ginseng, paying two pounds of tea for one pound of root. The sloop returned and sold the tea at an enormous profit. The captain of the Albany sloop *Experiment*, hearing of the great price the Britishers had paid for ginseng, concluded that the Chinese would give more than the British, and on December 15th, this sloop, measuring 84 tons, with a crew of seven men and two boys sailed past Sandy Hook for Canton and covered the 15,000 miles of salt water between New York and that port." The enterprise which marked the history of the early American marine is well exemplified in these instances. Were existing obstacles removed this same enterprise would be again manifested.

"SEABOARD," quoting the *Journal of Commerce and Commercial Bulletin*, endorses the opinion that the present Atlantic liner has very nearly approached its maximum speed. The "shrinkage of time is now numbered by minutes. "Reference is made to Col. Elsdale's opinion given in the *Contemporary Review* some six months ago. "He pointed out that with the increase of propulsive power on steamships, extra resistance is piled up to meet and swallow it up. The head resistance figures but little, it is the surface or skin friction that accounts for much the larger part of the total resistance to a vessel's motion through the water." He thinks it will be found that a smooth surface of iron or steel is about the worst which we can give to our ships, regarding this surface as possessing maximum adhesion for water among materials available for shipbuilding; and he apparently looks for the discovery of some substance that being applied to ships' bottoms will reduce this skin friction, intimating that it may possibly be applied in a manner resembling the scales of a fish. Scales of paper or of ramie fibers were suggested as possibly being suitable for for this purpose. The increase of propulsive power, by the use of steam at two or three times the pressure now usual," and the transformation of its energy into electricity without the waste incidental to rotary motion are also regarded as on the eve of accomplishment. At all events it is quite evident that the limit of speed for vessels of iron, propelled by steam-engines and propeller screws will not be much lowered from present records.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25269. The Decennial Programme for Naval Construction in France (Eng L–Sept. 14.) 4000 w.

*25786. Feed-Water Heaters: Influence of Circulation on Economy. Ill. (S L–Oct.) 700 w.

25801. Boat with Propelling Turbine. Ill. (Sc A S–Oct. 13.) 900 w.

25804. Atlantic Coast Towing.—A Trip on an Ocean Tug. Ill. (Sea–Oct. 11.) 1800 w.

25857. Sailing Vessels. Editorial (Am S–Oct. 11.) 700 w.

*25916. Aluminum in Torpedo-Boat Construction. Editorial (E–Oct. 5.) 1000 w.

*25930. An Aluminum Torpedo Boat. Ill. (Eng L–Oct. 5.) 1300 w.

*25931. Chinese War Ships at the Battle of Yalu. Ill. (Eng L–Oct. 5.) 1600 w.

*26053. The Dover and Calais Service (E–Oct. 12.) 1100 w.

*26062. The Port of Grimsby. Ill. (Tr–Oct. 12.) 2200 w.

*26150. Development of Steamships in the Nineteenth Century. Ill. Uriel Sebree (Ch–Nov.) 3800 w.

26178. A Maritime Nation. George. E. Belknap (Sea–Oct. 25.) 800 w.

26205. Great Lakes to the Gulf.—Interior Deep Water Navigation (M R–Oct. 26.) 2000 w.

*26211. The Shipbuilding Industry. Editorial (E–Oct. 19.) 1700 w.

*26306. The New Port of Bizerta (Tr–Oct. 19.) 1200 w.

*26316. The Manchester Ship Canal.—Report to the Board of Trade (B T J–Oct.) 1500 w.

*26334. A New South African Liner.—The Norman (Tr–Oct. 19.) 600 w.

26383. "The Future of Steamship Speed" (Sea–Nov. 1.) 900 w.

26395. The New Waterway to Rotterdam. Ill. (W. Gustav Triest (E N–Nov. 1.) 7000 w.

26458. Preliminary or Dock Trials of a Battle-ship at San Francisco. Ill. G. W. Dickie (M A–Nov.) 1800 w.

*26537. The Growth of Steam Navigation. Thomas Sutherland (I C T–Oct. 26.) 2800 w.

†26559. A Practical and Easy Method for Determining or Comparing the Free-Board. Ill. A. Bod (J F I–Nov.) 4500 w.

26562. The Practical Working of the "Chicago's" Machinery and Boilers. Ill. (Ir Age–Nov. 8.) 3600 w.

26564. The American Line Steamer "St. Louis." Ill. (Am S–Nov. 8.) 1300 w.

26616. Our Greatest American Steamship.—The St. Louis. Ill. (Sea–Nov. 8.) 2500 w.

*26549. Shipbuilding in Germany (F'y–Oct. 19) 1200 w.

*26650. The S. S. Nineveh of the "Aberdeen Line" to Australia (F'y–Oct. 26.) 1000 w.

*26651. The Seamen's Union.—How the Money was Spent (F'y–Oct. 26.) 1000 w.

Serials.

16636. Marine Engine Design (M W–Began Oct. 6, 1893—16 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E–Began April 14—21 parts to date—45 cts. each).

26091. Some Points in Modern Marine Engine Practice (I & I–Began Oct. 12—3 parts to date—30 cts. each).

26182. Development and Construction of the Marine Boiler. Ill. (M W–Began Oct. 19—1 part to date—30 cts).

MECHANICAL ENGINEERING

American Machine Tools.

AN article written by Prof. John E. Sweet and printed in the *American Machinist* some months ago, charged a boastful character upon American mechanical engineers; and an attempt to sustain the contention was made by a citation of some of the things done in English and European countries regarded as fine work and difficult to perform. There seemed in this an implication that American mechanics had not much reason to estimate themselves as superior to foreign mechanics if they were even equal. A considerable discussion was thus aroused. It was denied by some that Americans are unduly boastful. It was claimed by others that they had good grounds for supporting the claim of superiority over foreign mechanics. By others it was held that a dispute over such a question is futile and foolish. Notwithstanding this assertion, in the course of the debate many instructive exemplifications of the skill attained in mechanic arts both in America and in foreign lands have been drawn out.

Some of these are contained in an article by T. F. Haggerty in the *Illustrated Carpenter and Builder* (London). Having traveled extensively in Europe and Australian colonies, he asserts that Prof. Sweet's charge of boasting against Americans is only a reiteration of what he hears everywhere abroad. What is called boasting is only a defense of American institutions and industries against those who decry them, except in the case of politicians to whose utterances when examples of offensive boasting are cited, they can usually be traced. This "brag" does not originate with mechanics who are as ready to give credit to foreign merit in workmanship as they are to claim it for their own productions.

In the matter of sawing lumber Prof. Sweet charged that it is better done, and with less waste abroad than in the United States, and Mr. Haggerty replies:

"This would be valuable information to our lumbermen, if they could only know how it is done. Less waste of lumber, no doubt, but with great waste of time; time is the most important item of value, and where material is plentiful then material is wasted and time saved; this is the cause of the success of American workmen. They weigh all the elements entering into any problem, and figure on how much time and money will be saved. The average output of one bandsaw mill I could name, per ten hours' time, is 125,000 feet, board measure, of pine lumber."

Prof. Sweet charged that "in nearly all countries except England iron casting is a fine art" compared with this industry in the United States.

"The facts are just the other way as was shown at the Centennial Exposition at Philadelphia. The kind of castings is not here stated, yet I can say without fear of successful contradiction that the American cooking and heating stoves are works of art such as are not made in Europe; such fine castings as are made in our household hardware of all kinds are unknown to Europeans. If there are such artistic iron-molders in Europe, how is it that none of them show up in the large number of molders that emigrate to America? Is it not a fact that European mechanics in this branch have to receive instruction in our shops before they can get journeyman's wages?"

Prof. Sweet charged that "a better built Corliss engine than was ever built in this country was exhibited at the Paris exhibition."

"If we only knew what was meant by 'better built,' we might be able to determine the difference. Probably highly-finished parts are meant; if so, we could take that same engine, finish it all over and nickel-plate it if it was required. We have seen such engines on exhibition in America. The fact that the French put such fine finish on a Yankee engine leaves them nothing to boast of. Perseverance and emery on a stick, in the hands of a good workman, produce a good finish, but it requires a different order of talent to invent a new type of engine."

Prof. Sweet credits Europe with machine tools better designed, with better material and better workmanship than the American. "If he has seen any such they were as he says *on exhibition*, and no doubt from American designs."

Prof. Sweet spoke of the making of a "steel turret head 6″ thick and 10″ diameter, boring seven or more holes through it and hardening the thing as hard as fire and water will make it"; and the general tenor of his remarks leaves it properly to be inferred that he thought this a difficult piece of work, and one that would not be done as well in America as in Europe. Mr. Haggerty vigorously denies this implication.

"I can see nothing difficult in that, and I can safely say that I could go into any ordinary machine shop having proper facilities and get an estimate on any number of them to be delivered in a given time. As this example is given to show how proficient the English, or Germans, are in steel manipulation and risky feats of tempering, I will present an example of American skill in that line as an offset. In American tool manufactories, where there are a large number of parts to be forged, from the smallest scissors blank to the largest-sized tinsmith's bench shears, no matter what the first cost of the dies may be, or how long it takes to make them—provided they will do the work required—they are ordered without delay. After the largest sized blank of a bench shears, say 36 inches long, is struck up between dies, there is a thin burr left around the die, which requires to be trimmed off close to the main body. Imagine a long female die, with a punch to match it, requiring over 200 pounds of tool steel; keep in mind that this is not an iron die with steel welded on the face, such as is used in Europe. It is now required to finish and fit this pair of trimming dies, and temper them 'as hard as fire and water will make them,' and to draw the temper to the required degree of hardness. I have seen a pair of dies thus manipulated. When finished, the male die was laid back down, on a planer bed, and the female die was placed over it to about the depth required when in use, the four corners of the female die being held to a horizontal balance. When thus connected, water was thrown into the top or female die and not one drop ran through between the upper and lower dies. It will be asked how this set of dies was hardened and drawn to temper without twisting or shrinking. I would answer that nothing is left to blind chance in a shop or factory where perfection is the aim, and in this and other instances of a similar kind, the risk of cracking the female die being great, provision is made for subjecting only the cutting edge to the chilling influence of the water, leaving the main body nearly soft. The man who made that set of dies and tempered them would regard it an easy task to make and temper the steel turret."

It is noteworthy that whereas an American machine manufacturer criticised the mechanical ability of Americans, a vigorous refutation of the criticism is thus made in the columns of a foreign publication.

Tee-Squares.

THE tee-square and drawing board are among the first implements employed in the development of a mechanical conception. No handy substitutes for them have been found. Simple as they are, much study has been devoted to their construction and improvement. The latest of these studies made public,has been by Mr. Oberlin Smith, who makes in the *American Machinist* some suggestions worth considering. The changes suggested are illustrated in the accompaning cuts. Mr. Smith does not claim these to be entirely original with him; Prof. J. B. Webb, was also a collaborator, and both gave thought and time to the subject.

"The result of these cogitations was a drawing board made as shown in front view in Figure 2, upon which was mounted a special tee-square, as shown in front view, Figure 1, and top view in Figure 3. The general idea originated, as I remember, with Professor Webb, but was worked out by both of us. The only new feature in the drawing board is a groove *G* near the left hand end about one inch wide and, perhaps, three-eighths inch deep. Beneath the blade of the tee-square *B* was pivoted the lever *L*, the front end of which projected above the drawing board as shown in Figure 1, and the rear end of which was pulled toward the head of the tee-square *H* by the spiral spring *S*, hooked on to two ordinary round-head wood screws, inserted in the head and lever respectively.

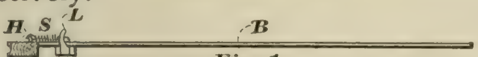

Fig. 1

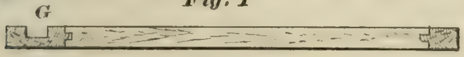

Fig. 2

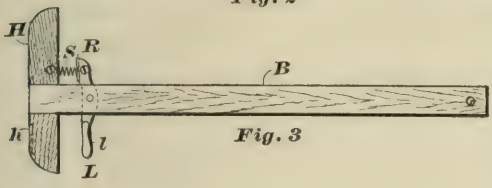

Fig. 3

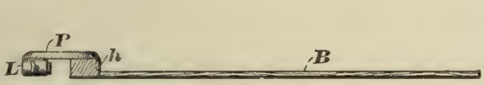

Fig. 4

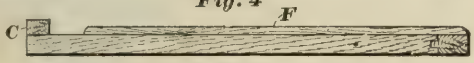

Fig. 5

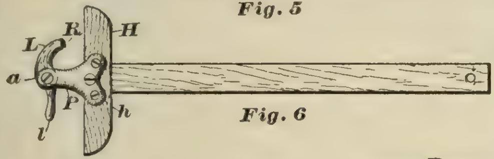

Fig. 6

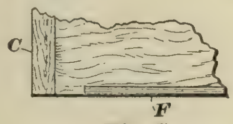

Fig. 7

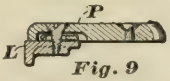

Fig. 9

Fig. 10

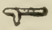

Fig. 11

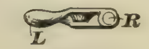

Fig. 8

American Machinist

"Cemented to the working end of the lever was a small pad of rubber *R*, whose function it was to give more friction against the left side of the groove *G*, when the square was down in place and the lever freely sliding therein. A flat spring, attached to the side of said lever and abutting against a pin projecting downward from the square blade, would, of course, have been as good and somewhat neater. The cheapest way of all would be to hook an ordinary rubber band over the screws, in place of the spiral spring *S*, but in those days these useful little bands were more of a curiosity than now.

"The action of this square is self-evident, inasmuch as the head is firmly clamped against the left edge of the drawing board by the action of the spring and lever, instead of being held there by hand, thus leaving the two hands of the draftsman free to use his triangles, pencils, pens, etc., against the rear edge of the blade. The movement of the square forward and rearward upon the board is obviously as quickly performed as with the ordinary tee-square, as it is just as easy to grasp the slightly indented head with the fingers of the left hand at *h*, with the thumb upon the lever at *l*, at the same time giving a slight pressure to overcome the spring and release the square, as it is to grasp the head of the square itself. In cases where the drawing board lies down flat upon a table the square is indeed easier to grasp than usual, as the fingers do not have to be thrust beneath it. This is a device that can be cheaply applied to any tee-square already in use, providing the drawing board upon which the same is to be mounted will permit, without too much weakening, the planing out of the groove *G*. If desired, this groove can be made under cut on the left side, in dovetail fashion, so as to give a holding down effect upon the square, but in practice we do not find this necessary.

"In Figure 5, in front view, and in Figure 7, in partial top view, is shown a somewhat different type of drawing board, which I have adopted in recent years for my entire equipment. It requires no groove, and the left end is strengthened simply by screwing fast to it the cleat *C*. Incidentally, but having no connection with the use of the tee-square, it may be mentioned that these boards are made with a flange *F* projecting upward from the front edge about one-half inch high. This is often very convenient for preventing the tools from sliding off when the board is inclined, and more especially for resting the true front edge of the paper against in various cases of sketching and designing where it is not necessary to fasten it down, with thumb tacks or otherwise. In fact, nearly all our work is done with the paper thus loose, though possibly one reason why we do not feel the need of any fastening is that we use cross ruled paper not only for sketching but for all scale drawings.

"The tee-square used upon this board, in cases where not more than three feet of length is required, is shown in front view in Figure 4, top view in Figure 6, etc. It is made like an ordinary tee-square, but with its head reversed, so that it projects upward from the blade and so that its left side slides against the right side of cleat *C*. To this cleat it is firmly held by the iron lever *L*, provided with a rubber pad *R* at its rear end, consisting of an ordinary rubber cork inserted in a drilled or cored hole. This lever, of course, presses against the left side of *C*, thereby clamping the square in any desired position. It is released by pinching the front end at *l* with one or more of the fingers of the left-hand, the thumb resting in a slight indentation *h* at the right side of the head *H*. In Figure 8 is shown a right view of the lever and rubber pad. In Figure 9 is shown a front vertical section of lever *L* and a plate *P*. This latter is fastened to the top of the square with ordinary wood screws, and to it is pivoted the lever by a machine screw. The actuating spring is a simple piece of bent wire shown in section in Figure 9, in top view in Figure 10, and in right view in Figure 11. The straight end of this spring lies loosely in a groove cast in *P*, while the bent down end enters a rough hole cast in *L*."

Mr. Smith declares that, "after several years' experience he would not return to the old drawing board and tee-square, but the improved forms are not advised for use with squares having blades exceeding a length of three feet. For lengths exceeding this the well-known 'Bergner method' is preferable." But the use of elastic steel wire working around pulleys of comparatively large diameter has been found superior in accuracy to the twine and small pulleys employed by Bergner. Mr. Smith claims to have independently invented the device patented by Bergner, though he does not dispute Bergner's priority. This is not an infrequent occurrence in the history of modern invention.

Governing Electric Light Engines.

An excellent article to read in connection with that upon the Ideal Steam Governor, written by Mr. H. J. Conant, and printed in the October number of this Magazine, is one printed in *The Engineer* (London) in its issue of September 28th. The well known defects of centrifugal governors are treated, and it is editorially stated that the office of the publication named is besieged "at various times and from various quarters with letters complaining of the difficulty which the writers find in obtaining governors which will satisfy the demands of the electrician."

All the centrifugal governors in the market apparently have been tried; not any gives complete satisfaction. It is queried whether the governor needed cannot possibly be made, or whether it is beyond the powers of inventors to produce such a governor. The assumption is made that a negative reply to either of these queries is not necessary to be given, and the reason assigned why the desired governor is not obtained is simply "because the electric light engineers have not explained fully what they want and—which is perhaps more to the purpose—why they want it."

An attempt is essayed to make good this deficiency. The well-known fact that none of the centrifugal governors can act instantly upon a variation of load is cited and a number of illustrations to emphasize this proposition are given.

> The great initial difficulty remains untouched, namely, the power of the governor to deal with lightning speed with large alterations in load. What appears to be needed is a governor which the moment the speed drops or rises—say 1 per cent.—will open the throttle valve full or shut it absolutely, and will then by a series of very rapid alterations or oscillations open and close it through smaller and smaller arcs until the new position suited to the load has been attained. Something quite analogous to this is found in the gas engine, and it is by no means certain that the same principle might not be applied with advantage to the steam engine. Messrs. Brown Brothers make an anti-racing gear for marine engines. Mr. Weir has, we fancy, something o the same kind. The moment the engine tends to race, the inertia of a small moving weigh

opens a trigger and the throttle valve closes. We have here the fundamental idea of a governor for electric light engines. The isochronal governor complies well enough with the conditions up to a certain point. The balls will remain in any position independent of the speed ; it is only a change in speed that will cause them to move in or out, to or from the central spindle ; but the isochronal governor is altogether too delicate a plant for the engine-house of an electric light station, and, besides, it is prone to "hunt" to a most distressing degree.

A position is taken which will probably be criticised. The proposition is made that whether the governor acts on the throttle valve or on the expansion gear is a matter of no consequence as far as governing is concerned. In proof of this assertion the statement is made that where an expansion gear governor has been taken off and replaced by the throttle valve governor "excellent results were obtained with no appreciable difference in steam consumption." It is added that "throttle valve governors generally fail because the valve is not properly constructed. There is no sort of relation between the area opened and closed and the position of the governor. The result is of course disappointing."

An arrangement is suggested as being better than those in use, which consists in passing the steam through a circular orifice in a plate in which moves a cone. It is assumed that while a sufficient taper on this cone would require a very long range of motion to make any material alteration in area opened for the steam to pass, if the sides of the cone be curved, "any relations desired may be obtained between the position of the governor and the area for steam admission."

The satisfaction which some electric light engineers find with some of the governors in use is asserted to be based on ignorance. "They do not know what a first rate governor could do for them." In concluding it is claimed that there is "no doubt that any competent inventor who would take the trouble to master the whole question could produce what is desirable." In other words, the governing of steam engines is considered as a very simple problem, or at least, so simple that it ought not to give any serious difficulty. It is doubtful whether this proposition will be accepted by engineers in general, most of whom regard the production of the ideal governor as a matter of considerable difficulty and doubt whether it is possible to so construct a governor that it will regulate the admission of steam simultaneously with variation of load.

The Gas Engine.

In a lecture delivered by Mr. W. Norris, M. I. M. E., before the Lincoln (England) Schools of Science and Art, he gave an interesting account of the beginnings and progress in this new popular class of motors, which the *American Gas Light Journal* has printed (Oct. 15), under the title "The History and Development of the Gas Engine." The use of explosives in guns was the starting point of invention in this line. Instead of a projectile to be thrown out of a hollow cylinder to a distance, in the gas engine a piston has been substituted. The effort of this piston to escape from the cylinder, as a projectile would do, is arrested by a crank and pitman, and converted into work by the motion of these parts against resistance.

Combustible powder whose rapid burning generates a large volume of heated gas, has been almost wholly employed for artillery. Each separate gun may be regarded as a heat engine, as much as a steam engine or a caloric engine is; and guns were the earliest heat engines, with perhaps the single exception of the Greek æolipile, which, however, was merely a philosophical toy. Attempts were early made to use explosive powder in motors for industrial purposes. It is stated that the first proposition to do this originated with "Abbé Hautville, the son of a baker of Orleans (1678). To him belongs the honor of designing, not only the first engine worthy of the name, but the first machine using heat as a motive force." In this device powder was burned in a vessel communicating by a pipe with a reservoir of water ; a large volume of the gases escaped through a valve, and when the residue of the gases cooled after combustion, atmospheric pressure forced water up through the pipe into the vessel to fill the partial vacuum thus formed. There were many difficulties to be met. Huyghens and Papin endeavored to overcome them, but abandoned their attempts and engaged in experiments with steam. Then for more than a hundred years steam held the innings.

The first to design and construct an actual gas engine is alleged to have been John Barber, who took out a patent for such a machine in 1682. He made his gas from wood, coal oil, or other substances heated in a retort, condensing and cooling the gas in a receiver. The gas was then mixed in the proper proportion with atmospheric air and forced by a pump into a vessel called the exploder. From an aperture in this vessel, the expanding gases issued in a stream and impinging upon the vanes of a wheel caused the latter to rotate. As a supposed aid to this action, a small jet of water was injected into the exploder, and being converted into steam was thought to increase the volume of discharge.

The history proceeds in due sequence to the gas engine invented by Robert Street (1794), in which gas exploded in a cylinder and impelled a piston. This type of gas engine has held supremacy up to the present time. Lebon's gas engine (1799 and 1801) is next in order of time. This though it was in advance of the age, appears to have been the first which indicates an appreciation of the advantage of compressing the mixed air and gas in the motor cylinder prior to the explosion. Sixty years later Lenoir successfully introduced gas engines working on this principle, which is employed in more recent gas engines that have been successful as motors. Next came Brown's invention (1826) in which condensation of the expanded gases was effected by a jet of water. Since this date improvement has been rapid.

Steam Jackets and Separators.

THERE exists in the Canadian Dominion an Association of Steam Engineers, and this body of practical men, recently held a convention at Toronto during which some good papers were read. Among these was one presented by Mr. J. Murphy of Montreal (printed in the *Canadian Engineer* for October) in which points that have come under Mr. Murphy's observation while practically in charge of condensing and compound condensing engines were brought to the attention of the convention.

The fact that there is great difference of opinion with reference to the merits of steam jackets is mentioned but passed with mere allusion to the existence of diverse views of the subject entertained by theoretical as well as practical men.

"In the short space of time that I have been working with jacketed engine and separator, I have seen wonders with regard to good running and efficiency; but it is not my intention to advertise those builders that have already adopted the jacket; it is simply to lay before you what I have found in practice. I will describe as briefly as possible the way that the steam connections to these jacketed engines are designed. The high-pressure steam chest of the engine, and the receiver jacket is supplied from the high-pressure cylinder jacket; the return pipes from the jacket are run to a pump that is situated below the level of the return pipes, and the water that is condensed in the jackets is pumped automatically back to the boilers. The low-pressure cylinder jacket is supplied from the initial pressure of the low-pressure cylinder, and the condensed water from the low-pressure jacket is also pumped back to the boilers automatically with a pump similar to the one for the high-pressure jackets. These pumps can be regulated and worked by hand in case of any disarrangement of the automatic regulating gear. There is also an independent way of draining these return pipes into a cesspool connected with the sewe that is used when making repairs to thes pumps, so that you will see there is n further loss than that which is due to radiation. The steam separator is co nected with the main steam pipe abou ten feet below its level, and at the end o it, so that any water that may get into th main pipe through condensation or other wise may find its way to the separato and is pumped back to the boilers by the high-pressure jacket pump. The separator effects a considerable saving because there are no other drips necessary on the main steam pipe. while such are required on the ordinary steam pipe that is not connected with a separator.

An experience with Brown and Corliss engines in the Royal Electric Company's works during a number of years is given. "That these engines worked well goes without saying. The compound engines were the latest installed at their works, and when I say that these engines worked well I simply say the truth. The entire experience confirms the value of steam jacketing."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated W=Words.

The Machine Shop.

*25765. Economy in Machine Shop Management.—A Plea for Handy Devices and Handier Workmen. James Brady (E Mag–Dec.) 3500 w.

25777. The Greiner and Erpf Cupola. W. F. Durfee (A M–Oct. 11.) 1300 w.

25779. Figuring Drawings. Oberlin Smith (A M–Oct. 11.) 4000 w.

25910. Welding. S. Uren (R A–Oct. 12.) 2500 w.

*25933. Spratt's Electrical Speed and Direction Indicator. Ill. (Eng. L–Oct. 3.) 1300 w.

25997. Punching Sheet Steel in a Planer.—A Milling Attachment to Planer. Ill. James F. Hobart (A M–Oct. 18.) 1200 w.

26172. A Few Examples in Pattern Making. Ill. John M. Richardson (A M–Oct. 25.) 850 w.

26173. What Is a Chronometer? (A M–Oct. 25.) 1200 w.

26175. Tee-Squares. Ill. Oberlin Smith (A M–Oct. 25.) 1200 w.

26357. The Machinist in the Foundry. Editorial (A M–Nov. 1.) 700 w.

26398. A Large Steel Derrick. Ill. (E N–Nov. 1.) 900 w.

26463. The Slide Rule in the Shop. William Cox (M A–Nov.) 1300 w.

*26536. Drilling Machines for Cylindrical Boiler Shells. Samuel Dixon (I C T–Oct. 26.) 4000 w.

26573. Making Formed Milling Cutters. Ill. Warren E. Willis (A M–Nov. 8.) 1100 w.

26575. Measurement of Areas Bounded by Curved Lines. F. R. Honey (A M–Nov. 8.) 600 w.

26654.—$1.50. Friction Rollers.—Discussion on C. L. Crandall's Paper. J. B. Johnson and A. Marston (T C E–Sept.) 2400 w.

Steam Engineering.

*25820. The Strong Internally Fired Boilers (I & I–Sept. 28.) 1500 w.

25851. Limits of Accuracy of Steam Engine Indicators (R G–Oct. 12.) 800 w.

*25878. Piston Valves for Steam Engines. W. H. Booth (E R L–Oct. 5.) 1400 w.

25887. Steam Jackets and Separators. J. Murphy (C Eng–Oct.) 1700 w.

*25899. The Arrangement and Drainage of Steam Pipes. Editorial (P Eng–Oct. 5.) 1200 w.

25938. Designing Engine Cylinders.—The Effect of Large Clearance Surface on Economy. Ill. (B J C–Oct. 13.) 2500 w.

25939. Feed Pipes Clogged (B J C–Oct. 13.) 1200 w.

25946. First Stationary Steam Engines in America. F. R. Hutton (M G–Oct. 13.) 900 w.

26021. Economy in the Boiler Room. John C. McHynn (S V–Oct. 15.) 1100 w.

26022. Special Automatic Stop Valves in France. Ill. Thomas Powell (S V–Oct. 15.) 1400 w.

26045. Some Interesting Diagrams. Ill. (B J C–Oct. 20.) 700 w.

26046. Boiler Feed Waters (B J C–Oct. 20.) 900 w.

*26159. A Perfected Steam Fire Engine. Ill. (M–Oct. 15.) 2000 w.

*26160. The Management of Steam Engines.—The Engineer's Duties and How He Should Perform Them (M–Oct. 15.) 1300 w.

26174. The Great Boiler Explosion.—"Penny Wise, Pound Foolish." W. Barnet Le Van (A M–Oct. 25.) 80c w.

26301. Some Engine Experiments.—Hot vs. Cold Cylinder Walls (B J C–Oct. 27.) 1400 w.

26302. Corliss Engine Valves.—Short Directions for Setting Them (B J C–Oct. 27.) 1000 w.

26304. The Formation of Scale in Boilers, and in Feed, Circulating and Blow-off Pipes. Ill. (M G–Oct. 27.) 1800 w.

26392. Measuring Power. W. H. Wakeman (S M–Nov. 1.) 700 w.

26393. Testing Indicators (S M–Nov. 1.) 2200 w.

26416. Steam Pipe Covering. Walter Meyer Dickinson (H & V–Sept.) 900 w.

26461. Forced or Natural (?) Draft. Peter H. Bullock (M A–Nov.) 1400 w.

26474. Fly-Wheel Accidents.—A Discussion as to the Probable Causes (B J C–Nov. 3.) 1600 w.

26475. About Blow-Offs.—Common Practice That Is Not Safe (B J C–Nov. 3.) 1300 w.

26476. Condensation of Steam in Cylinders (B J C-Nov. 3.) 1000 w.

26481. Boiler Explosion at Shamokin, Pa. Ill. (Pr-Nov.) 1600 w.

26482. The Chilling Action of Feed Water. Ill. (Pr-Nov.) 2200 w.

26613. Rivals of the Steam Engine. George Mackie (C E N-Nov.) 1800 w.

Miscellany.

*25683. Governing Electric Light Engines. Editorial (Eng L-Sept. 28.) 1400 w.

*25823. Description of Bell's Asbestos Manufactory, Southwark Street. Ill. (I & I-Sept. 28.) 2800 w.

*25864. The Windmill in Theory and Practice. V. E. Johnson (Inv-Oct. 6.) 1600 w.

*25893. American Machine Tools. T. F. Hagerty (I C B-Oct. 5.) 4000 w.

25911. The History and Development of the Gas Engine. W. Norris (A G L J-Oct. 15.) 2000 w.

*25918. Canal Boat Propulsion. Ill. Henry Barcroft (E-Oct. 5.) 2100 w.

25942. Machine Operators' Specialties, etc. C. R. Tompkins (A S-Oct. 13.) 1200 w.

25982. A Drafting Room System (Ir Age-Oct. 18.) 1400 w.

25996. Compressed Air for Cleaning Carpets. Frank Richards (A M-Oct. 18.) 1500 w.

*26116. The Semet-Solvey Coke Oven at the Antwerp Exhibition (C G-Oct. 12.) 2400 w.

†26155. The Swiss Watch Schools. Ill. Theodore B. Wilson (P S M-Nov.) 1800 w.

†26333. Test of Otto Gas Engines. J. V. MacDonald, B. G. Braine, C. H. Merritt, Jr. (S In-July.) 1800 w.

26349. The Mechanic Arts and Modern Educations. R. H. Thurston (Sc A S-Nov. 3.) 5000 w.

26462. Hints for Machinists and Engineers. Ill. James F. Hobart (M A-Nov.) 1200 w.

26464. Boiler-Room Accidents. W. H. Wakeman (M A-Nov.) 2200 w.

26483. Stresses Produced in Fly-Wheel Arms by Change of Load or Sudden Stoppage. C. V. Kerr (Pr-Nov.) 1000 w.

*26492. The Friedburg Apparatus for Burning Coal Dust. Ill. (I & I-Oct. 26.) 1300 w.

*26514. Rolled Weldless Chains, Klatte's Process. Ill. (Eng L-Oct. 26.) 1400 w.

†26555. The American Gas Furnace Company's Fuel Gas System and Apparatus. Ill. (J F I-Nov.) 2800 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (M W-Began May 12—14 parts to date—30 cts. each).

13534. The Gas Engine. Ill. (M W-Began June 2, 1893—12 parts to date—30 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7, 1893—14 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El-Began Dec. 1, 1893—23 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M-Began Feb—9 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March—9 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Redinger (E M—Began April—8 parts to date—30 cts. each).

23826. Comparison of Different Formulæ for Dimensions of Parts of Steam Engines. William Kent (A M-Began July 26—6 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L-Began Aug. 31—6 parts to date—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y-Began Sept. 19—8 parts to date—15 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Theodore F. Scheffler, Jr. (M A-Began Oct.—2 parts to date—15 cts. each).

25531. On Resistance of Trains of Mechanism. Ill. Leicester Allen (M A-Began Oct.—2 parts to date—15 cts. each).

25538. Testing of Engines and Boilers. Ill. Charles Day (P Eng-Began Sept. 21—4 parts to date—30 cts. each).

25563. Spacing Holes. Ill. Easy Way (A M-Began Oct. 4—2 parts to date—15 cts. each).

25735. Notes on the Steam Turbine. Kenelm Edgecumbe (E R L-Began Sept. 28—Ended Oct. 19—4 parts—30 cts. each).

25922. Some Points in the Testing of Steam Engines (I & I-Began Oct. 5—4 parts to date—15 cts. each).

25923. Waste of Energy in Machinery (I & I-Began Oct. 5—2 parts to date—30 cts. each).

26044. The Magnitude and Importance of the Industries Involved in Wire (Inv-Began Oct. 13—3 parts to date—30 cts. each).

26104. Fire Protection in Mills and Factories. Ill. (F W-Began Oct. 20—Ended Oct. 27—2 parts—15 cts. each).

26154. Manual Training. C. Hanford Henderson (P S M-Began Nov.—1 part to date—45 cts).

26181. Refrigerating Machines. Ill. A. R. Gale (M W-Began Oct. 19—2 parts to date—30 cts. each).

26250. The Modern Gas Engine. E. Rollason (P Eng-Began Oct. 19—Ended Oct. 26—2 parts—30 cts. each).

26488. American Steam Raising Plant. Ill. (I & I-Began Oct. 26—1 part to date—30 cts).

26590. Changing a Steam Plant to Improve Economy. Thomas Hawley (B J C-Began Nov. 10—1 part to date—15 cts).

26598. Fly-Wheel Accidents. J. J. Flather (E W-Began Nov. 10—1 part to date—15 cts).

MINING & METALLURGY

Physical Properties of Fuels.

In a contribution to the *American Manufacturer* Mr. John Fulton presents a clear and rational explanation of the behavior of metallurgical fuels in the blast-furnace, showing why certain results apparently discordant if viewed only from the standpoint of chemical composition are the natural outcome of the different physical properties of the fuels. In American blast-furnace practice, as elsewhere, charcoal was the first and sole fuel. Later it was replaced in part by anthracite; and later still coke has taken the ascendancy, while mixtures of coke and coal remain in use. Mr. Fulton reviews these changes, giving statistics of the relative proportion of each fuel used at different periods, and setting forth the reasons for the changes.

In the examination of the physical structure of these three principal fuels, he observes, it will readily appear that charcoal inherits the structure of the wood from which it has been made, and that its structure consists of a series of longitudinal tubes, uniting with each other and affording a passage for the furnace gases. The walls of these tubes are readily oxidized; charcoal is therefore a moderately energetic fuel, as well as one of remarkable purity. But with an ever widening sweep of the charcoal supply from the furnace, and with increasing cost, it was forced to take a secondary place among metallurgical fuels, and with the advent of anthracite coal in blast-furnace use a new period in the manufacture of iron was opened.

Anthracite he considers to be a natural coke, made under immense pressure and heat. It is the densest of all fuels, as it practically inherits neither cells nor pores, but is a mass of fused and compacted coal. Because of its physical structure it is the least energetic of the fuels under consideration; but its combustion in the furnace is somewhat relieved by decrepitation, thus increasing the surface exposed to oxidation. Its hardness enables it to withstand great furnace burdens, and also enables it to resist dissolution by hot carbon dioxide.

Coke is made in ovens by destructive distillation, somewhat similar to the methods of preparing charcoal; but Mr. Fulton points out the important difference that coke results from the fusing of the coal and does not inherit any traces of the structure of the coal, while on the other hand it acquires a series of irregular cells connected with each other, thus affording the largest surface to the action of the furnace gases, and hence is the most energetic fuel of the three. Its hardness enables it to bear the burden of the highest furnaces and resist dissolution by hot gases. Thus it embraces in harmonious combination the best properties of charcoal and anthracite.

Mr. Fulton shows by figures that the assumption that a pound of carbon in any fuel should produce equal calorific results does not hold good in iron smelting. It is quite evident, he says, that the cause for the difference in the calorific work of these fuels is not to be found in the chemical composition, for the best product per pound of fuel and unit of carbon is given by the coke, which is the least pure of the three (that is, including ash), and that it follows, then, that the superior value of the coke is due to its physical structure. In the best qualities the cellular spaces in the whole volume of the coke are practically 50 per cent. and the aggregate surface of this cellular development with the slender columnar structure of the coke, secures the utmost calorific energy in the furnace and the greatest economy of fuel. Charcoal, with its tubes and enlarged outer surface, surpasses anthracite because of its physical properties, while coke largely surpasses both. Comparisons are made by Mr.

Fulton between the working of three typical furnaces, each running on one of the three fuels alone, but otherwise under similar conditions. As to amount of product, taking the total output of the three at 100, they stand: charcoal, 30 per cent.; anthracite, 17 per cent.; coke, 63 per cent. And comparing the speed of production, taking the charcoal furnace at 100, the showing is: anthracite, 80 per cent.; coke, 311 per cent.

Slate: Its Formation, Extraction and Uses.

In the *Canadian Mining Review*, Mr. H. J. Williams discusses the utility and value of slate, its occurrence and distribution, especially in the province of Quebec, and the methods of extraction and use, and calls attention to the growing importance of the slate industry. The author takes the risk of saying that no clay slate of any value is found in the Laurentian range or anywhere in Ontario, and proceeds to give a list of occurrences in Quebec, mentioning the places where quarries have been operated. He considers that from the number and variety of the slate deposits of the latter province it would appear that many remunerative quarries might be opened.

The author gives an account of the composition and geological origin of slate and then proceeds to describe the working of a quarry. He takes occasion to remark that there is no mining in which such intelligence, skill and judgment are required on the part of the employés as in the quarrying and working of slate. The method of quarrying is dependent upon the locality of the opening, the condition of the formation and the position relative to the surrounding rocks. It may be: (1) an open quarry; (2) a chambered quarry worked underground by adits and levels; or (3) an underground working opened by shafts. The author confines himself to a description of the first only, as with one exception all the quarries worked on this continent are of that class. In the Canadian slate beds the weathered covering is from 30 to 40 feet in depth, all of which has to be removed before sound slate can be reached. An opening is made along the face and another across the "vein." This portion is quarried back, another bench started in the same way and so on until the opening is laid out in a succession of steps. The next operation is the quarrying of blocks, and it is here that the most intelligence is necessary, it being imperative that the block shall be got out without shattering, and the skill of the quarryman is tested by his ability to take advantage of the slips, joints and floors to make each hole do its work properly. In some cases wedges are used, but usually blasting is resorted to. Ordinary black blasting powder is used, as the force wanted is a dull, heaving one which will displace the rock without breaking it. The higher explosives are of course inadmissible. The author next describes the cutting up of the large block by hand into convenient sizes for hoisting and trimming. In working these pieces into "slate" skilled labor again is requisite, and "slate makers," so-called, who usually work in pairs, study their block that they may make the most slate therefrom. The most important product is roofing slates, and the manner of splitting and trimming these and school slates is given. Another large and growing branch of the industry is in the milling of slate. There is no rock which so nearly resembles wood as this, and hence it is cut by circular, band and jig saws, and is machine-planed. For interior construction and ornamental use it is often "marbleized," and can also be used for tanks and vessels containing water. The other uses of milled slate are very numerous and varied. Among these are billiard table beds, blackboards, monuments, and switchboards and instrument stands for electrical purposes, etc. Mr. Williams mentions also one other use of rough slate which promises to be a very important branch of the industry—the grinding of the rock into dust from which is made a brick whose compactness and wearing qualities are unexcelled; and in the same way tiles of various colors, plain or glazed. are produced.

At present the slate industry of Quebec is confined to two large, well equipped quarries, at New Rockland and Danville.

Broken Stamp Stems and Crystallization by Vibration.

THE discussion started in the American Institute of Mining Engineers as to whether or not stamp stems break because of vibration and incessant shocks is not yet closed. *Engineering News* has adverted to the matter on several occasions, and in a recent issue returns to it, the occasion being a report from El Callao mill, Venezuela, in which the crystallization theory is reaffirmed. At this mill a record has been kept of the breakages, which, with 60 stamps running, for five years showed an average life of about 46 weeks, which is rather low. The stems are wrought iron $3\frac{7}{16}$ inches diameter; total weight of stamps (when new), 848 pounds; speed, 95; drop, 8 inches. The stems alone weigh 392 pounds. The writer of the report says: "I believe as a rule the broken stems are due to the metal crystallizing. Slight differences in vibration and strain and composition of metal vary the length of time required to crystallize sufficiently to cause a fracture. The average life of the stems shows that generally the fracture is not due to flaws or heterogeneous metal, although this is sometimes the cause." Commenting upon this, *Engineering News* remarks that if there was some approach to uniformity in the life of these stems, "the evidence is good that some deteriorating influence was at work upon the stem from the time it was put in service. If the breakage were due to a chance hit giving a side strain, then such a chance hit would be as likely to occur at one time as another, and after the small percentage of stems with flaws was eliminated the 'death rate' should remain fairly constant, and there should be a fairly large number of stamps [stems] which would run for two years without breaking, and an occasional one should attain a much longer period of service."

As our contempory says, there are probably few better places to test the effect of vibration and shock on metal than a stamp mill, with its steady day and night work and its continual concussion.

Engineering News has advanced a novel hypothesis to account for the battery stem phenomena, namely, that it might be possible that "the compression at the lower end of the stem [where it usually breaks] might exceed the elastic limit of the metal. What the effect of such repeated compression beyond the elastic limit would be can only be conjectured; but we know that repeated stretching of metal beyond the elastic limit gradually makes it brittle. It is not unreasonable to suppose therefore that repeated compression of metal may cause a 'fatigue' that will gradually diminish its ability either to resist a steady strain or to absorb without rupture the energy of a blow." This is based upon the weght of tappet and stem above the point of fracture and also upon the material which the stamp shoe struck. This, with self-feeders or careful hand-feeding, is always a cushion of rock, and not the chilled cast-iron of the die, which latter appears to be a necessary assumption in our contemporary's hypothesis.

Engineering News recommends careful experimentation to determine this vexed crystallization question, and suggests it as a good field for thesis work by students of the western mining schools.

Steel vs. Wrought Iron.

THE *Practical Engineer*, taking as its test recent returns collected by the British Iron Trade Association, presents a vivid picture of the extent to which steel has replaced wrought iron as a constructive material, and further how open-hearth steel has gained upon and at length passed its rival, Bessemer steel. It is less than forty years since the Bessemer process was first made public, and it was not until ten years later that Siemens introduced the open-hearth method for the manufacture of steel; yet during this short period, which is practically much shorter because of the very slow growth of both processes at the beginning, there has been a complete revolution. It is a familiar history, the wonderful progress made by the Bessemer process, but it is not so generally known perhaps that another revolution has been quietly going on, the open-hearth steel having at length outrivaled the Bessemer. This change is well shown by the *Practical Engineer* in its comparison of the British statistics for 1890 and 1894. In the first-named year the total output of steel in Great Britain was 3,579,000 tons, of which 2,015,000 tons were Bessemer and 1,564,000 tons open-hearth. In 1894 the positions have changed, the output of open-hearth steel for the first six months of the present year being 1,026,469 tons, while that of Bessemer steel was only 810,392 tons. Thus open-hearth steel has not only largely replaced wrought iron, as was naturally to be expected, but it would also appear that for many purposes it has replaced Bessemer steel as well, though the latter, like wrought iron, will, our contemporary thinks, retain its special sphere of application, owing to its cheaper and more rapid manufacture. On the other hand open-hearth steel is used almost exclusively for purposes where ductility and capacity for subsequent working in the fire are of special importance, in spite of greater cost. Its special applications are for boiler and ship plates, etc., where reliability is the great desideratum.

Taking these two steels together and comparing them with wrought iron, it is shown that while in 1882 the total output of wrought iron in Great Britain was upwards of 2,800,000 tons, for the present year, estimated on the basis of the first six months, it will not exceed 1,000,000 tons. On the other hand the combined output of Bessemer and open-hearth steel is expected to be over 3,600,000 tons for 1894, against a little over 2,000,000 tons in 1882. These changes have brought about correspondingly great economic changes in the districts affected.

Utilization of Blast-Furnace Slags.

THIS old but ever timely subject is admirably discussed in *L'Industrie*, and a translation of the article appears in the *American Manufacturer*. The series of uses, possible and probable, already practically demonstrated or merely suggested, are reviewed concisely. The first and most natural idea, says *L'Industrie*, and perhaps one of the best as well, was to use blast-furnace slags as fertilizers, as is done with the phosphatic slags of steel making. The latter have superior fertilizing qualities, but the blast-furnace slags contain almost no combined iron and can be sold much cheaper. Their action would of course be different. Basic slags, that is, those containing less than 3.2 atoms of oxygen to 1 of silicon, are the slags to be considered. They furnish soluble silica, which is necessary to healthy plant growth, and is deficient in most soils unless the latter contain much alkali. When finely pulverized basic slag is scattered over the ground it decomposes rapidly, giving gelatinous silica and the hydrates and carbonates of the bases, and by reaction with the meteoric ammonia and nitric acid produces nitrogenous products. *L'Industrie* believes that further attention should be given in this direction.

The manufucture of "mineral wool" or "glass wool" is mentioned. This industry began in 1873. Very fair material was made at low cost with the slag run directly from the furnace, but had the disadvantage of containing sulphur, rendering it undesirable as an insulator under some conditions. A better product could be obtained by treating the slag with suitable flux in a cupola. The presence of sulphur is also a drawback which has thwarted almost every attempt to use slags in cement, mortar, artificial stone, etc. When ground sulphurous slag is mixed with slaked lime and water it decomposes. But, provided the slag is not defective in this way, it will give hydraulic properties to mortars. From this it appears that blast-furnace slag would have had quite a commercial importance if it could be freed from sulphur. *L'Industrie* believes that it could be desulphurized in the liquid state as it flows from the furnace, and in an economical way; but this requires the coöperation of the iron manufacturers, who seem to have been indifferent to the matter.

A refined slag would have valuable properties, and it is suggested by our contemporary that it would be especially useful as a component in glaze for porcelain, etc. It is also suggested that there is the possibility of using certain slags in the manufacture of cheap glass, a matter which however will require much experimentation on a commercial scale.

The Genesis of Gold Placers.

THERE has been such a mass of literature, both in the form of official reports and of a more ephemeral sort regarding the origin and modes of occurrence of the auriferous gravels of California that the straw would seem to have been pretty well threshed out by this time; yet Mr. R. L. Dunn, in a two-part serial in the *Mining and Scientific Press*, has succeeded in presenting the subject in a somewhat new light, adding to the former literature (of which Whitney's "Auriferous Gravels" is the most prominent example) the results of observations made within the last few years and bringing the whole together in connected form.

Perhaps the most important point brought out in Mr. Dunn's paper is that the two principal types of placers, those of the existing streams and those of the Tertiary streams (the "deep" gravels), generally supposed to include all of the placer deposits of California, are in fact not the only ones. During the last two years, according to Mr. Dunn, the former notion has been disproved and there must be added two additional distinctive classes of placers, considered both with reference to mode of occurrence and to geological origin. One newly recognized form proves to be the gravel-filled bed of a Cretaceous or possibly Jurassic river (that is, of older origin than is attributed to other deep gravels), and is a conglomerated deposit. The other new type consists of marine conglomerates of Jurassic age.

The practical application of geological nvestigation of the placers is thus stated by the author: "A clear understanding of the phenomena of placer gold occurence and distribution will likely prove of onsiderable assistance in determining the probable gold content of placers. Though is not at all probable that any set of ules would prove conclusive in application o determining the gold content of every acer deposit, yet it is possible to so apply n exact knowledge of the formation of particular deposits as to have an added certainty to the correctness of conclusions relating to its mining."

Deep Mines on the Witwatersrandt.

THE persistency of the great "banket" lode of the 'Randt in depth has already been fully established by the diamond-drill holes which have been bored, and now deep shafts are being sunk at several points to exploit the lode. The *South African Mining Journal* gives details of the work thus far done, from which it appears that three shafts have reached depths of more than 800 feet. Where the "reef" has been struck it is said to be in every respect identical with that worked near the surface, so that the prosperity of this great gold-mining district is assured for a long time to come. One of the shafts (960 feet deep) was sunk without the aid of a pump and without rock drills in 24 months, the best record being 61 feet, in July. The shaft is not a very large one (5 feet by 9 feet 6 inches, inside timbers). The work was done by native labor and is interesting as showing what can be done by the native miners. They work in eight-hour shifts and are required to clean up the loose rock, which occupies about two hours. The water was all baled by skip. Comparing hand-drilling with rock drills, the *Journal* says that while the latter are more rapid, hand labor is less expensive—a state of things which does not generally prevail in other districts, and is doubtless due to the character of the labor employed on the 'Randt. The article cited gives full particulars as to work in several shafts and as to the surface plants erected.

Experiments With Mining Explosives.

THE *Colliery Guardian* contains a report of some experiments recently made in Wales for the purpose of testing certain explosives as to their safety for use in coal mining and also as to strength. The especial object was to compare the new "flameless" explosive westphallite with other brands, and although these tests were made under the auspices of interested parties, they are of considerable interest.

The tests as to safety were made in a horizontal iron boiler 30 feet long, in which the various explosives were fired in such manner as to represent blown-out shots. The apparatus was arranged to represent the condition of a dry colliery, (1) with coal dust and (2) coal dust in the presence of a measured quantity of inflammable gas. Observations were made through a series of windows along the sides. In the first set of tests dynamite, tonite, roburite, bellite and ammonite produced complete ignition of the dust, with large flame and explosion; while westphallite, andeerpowder and carbonite failed to ignite it. In the second set of tests the object was to ascertain whether the explosives which had not ignited the coal dust alone would cause an explosion in a mine where both dust and fire damp were present. The three explosives which passed the first trial successfully also succeeded in the more severe test, while roburite (which is considered a fairly safe explosive) caused an explosion with flame apparently of gas only. The tests for strength consisted in firing a 35-pound projectile from a mortar with 10 grams of charge, and measuring the distance to which the projectile was sent. The table shows the following order of apparent strength: dynamite, roburite, westphallite, bellite, ammonite, tonite, carbonite, andeerpowder.

An Aerial Ropeway at an Australian Colliery.

An account is given, in the *Australian Mining Standard*, of a plain endless ropeway lately installed at the Jumbunna colliery in the Gippsland district of Victoria for the haulage of coal from the mine tunnels to the railroad. The distance is one mile and the difference of elevation only 300 feet at terminals, with an up-grade to the railroad, but surveys showed that the construction of a branch railroad would have been so expensive as to be economically out of the question, on account of sharp curves and heavy grades over intervening country. The capacity of the line is 30 tons per hour. The case is interesting because of the selection of the plain single-rope system in preference to either of the more recently developed cableways.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

*25760. Electrical Power in the Iron Industries.—English and American Practice Compared. D. Selby-Bigge (E Mag–Dec.) 3500 w.

*25762. Aluminum the Super-Abundant Metal.—Present and Prospective Uses. Henry Wurtz (E Mag–Dec.) 3500 w.

25776. Modern Blast Furnace Practice. Editorial (Ir Age–Oct. 11.) 1000 w.

*25821. The Making of Tool Steel in Sweden (I & I Sept. 28.) 1000 w.

25842. Aluminum Bronze. Leonard Waldo (E N–Oct. 11.) 900 w.

25855. New Cupola, with Adjustable Annular Air Inlet. Ill. J. B. Nau, with Discussion (I T R–Oct. 11.) 2000 w.

*25869. Cyanide Processes on the Randt. Editorial (Min W–Oct. 6.) 1200 w.

25886. Methods of Cooling Steel. E. T. Clarage (Eng–Oct. 13) 1000 w.

*26057. Continental Competition in Iron and Steel (I & S–Oct. 13.) 2000 w.

*26058. Dressing of Spathic Iron Ore. G. Gromier (I & S–Oct. 13.) 1000 w.

26112. Suggestions for Building a Modern Blast Furnace. Ill. Guy R. Johnson (E M J–Oct. 20.) 1400 w.

*26146. The Cost of Treating Gold Tailings. (M J–Oct. 13.) 1000 w.

26167. Steel Boiler Tubes and Their Tests. Ill. (Ir Age–Oct. 25.) 1000 w.

26169. Reform Needed in the Bar Iron Trade. Editorial (Ir Age–Oct. 25.) 1000 w.

26170. The Armor Plate Frauds. Ill. Gus C. Henning (A M–Oct. 25.) 1500 w.

26203. Manufacture of Metals of the Alkalies and Alkaline Earths by Electrolysis. Ill. W. Borchers (Sc A S–Oct. 27.) 700 w.

*26226. The Future of Steel Manufacture (C G–Oct. 19.) 1200 w.

26241. Utilization of Blast Furnace Slags. (A M & I W–Oct. 26.) 1200 w.

*26246. American and English Iron making Conditions. Editorial (I C T–Oct. 19.) 1100 w.

*26252. The Wasting and Protection of Iron in Sea Water. (Extract.) C. Colson (P Eng–Oct. 19.) 1100 w.

*26257. Gold Mills. Editorial (M J–Oct. 20.) 1600 w.

26265. Manufacture of Steel Castings. James Larkin (F D–Sept.) 3000 w.

26266. The Fortimolite Process (F D–Sept.) 3000 w.

26291. Early Quartz Milling in Grass Valley, California. G. F. Deetkin (E M J–Oct. 27.) 800 w.

26294. Notes on the Treatment of Copper Scrap. Maurice Barnett (E M J–Oct. 27.) 1500 w.

26296. British Drift from Iron to Steel. Extract from London Times (I T R–Oct. 25.) 700 w.

*26339. The New Recovery Process.—More Important Than MacArthur-Forrest.—Electrical Precipitation from Cyanide Solution, with Editorial (A M S–Sept. 29.) 3500 w.

26358. Notes on Relative Tests for Cast-Iron, and Methods of Testing. Thomas D. West (A M-Nov. 1.) 4000 w.

26366. Comparison of Strength in Specialty Mixtures of Cast-Iron. Thomas D. West (Ir Age–Nov. 1.) 4000 w.

26396. Broken Stamp Stems and Crystallization by Vibration (E N–Nov. 1.) 1600 w.

26415. Chromic Iron. Its Properties, Mode of Occurrence and Uses. I. J. F. Donald. II. J. Obalski (C M R–Oct.) 4800 w.

*26465. Steel vs. Wrought Iron. Editorial (P Eng–Oct. 26.) 1000 w.

26493. Physical Properties of Metallurgical Fuels. John Fulton (A M & I W–Nov. 2.) 1500 w.

26494. The Volatility of Metals and Refractory Substances (A M & I W–Nov. 2.) 1400 w.

26521. Losses of Gold and Silver in the Fire Assay. Howard V. Furman (E M J–Nov. 3.) 700 w.

26522. Electrical Precipitation from Cyanide Solution. A. von Gernet (E M J–Nov. 3.) 2000 w.

26533. Some Remarks on the Cyanide Process. Edward A. Schneider (M I T–Nov. 1.) 800 w.

*26541. Gold Mills. Editorial (M J–Oct. 27.) 1700 w.

26583. The Capillary-Electrolytic Sluice in the Extraction of Gold. Joseph H. Jory (E M J–Nov. 10.) 1300 w.

Mining.

*25341. The Shaw Gas Tester. For Detecting the Presence and Percentage of Fire-Damp and Choke-Damp in Coal Mines, etc. Joseph R. Wilson (M J–Sept. 15.) 2700 w.

†25362. Stone Burning. F. J. E. Spring (I E–Aug. 25.) 800 w.

*25757. The Outlook in the Silver Mining Industry, in the Light of Recent Developments. Albert Williams, Jr. (E Mag–Dec.) 3500 w.

*25815. The Lithographic Stone Quarries of Bavaria, Germany. Ill. A. R. Crook (S–Oct.) 2000 w.

*25817. The Quarrying Industry in Indiana. Maurice Thompson (S-Oct.) 2000 w.

25870. Deep Level Mines of the Witwatersrand. (Abstract.) (E M J–Oct. 13.) 1200 w.

25871. The Georgetown Mining District, Montana. Ill. R. G. Brown (E M J–Oct. 13.) 9000 w.

*25921. Electric Traction by Accumulators in Mines. Ill. Joseph Libert (I & I–Oct. 5.) 6400 w.

*25925. Shaft-Sinking with the Aid of Divers. (Extract.) Ill. G. Nordenstrom (C G-Oct. 5.) 4800 w.

*25926. The Material Removed in Winning Iron Ore. Walter J. May (C G–Oct. 5.) 800 w.

*25928. A Year's Work in Colliery Drainage (C G–Oct. 5.) 700 w.

*25949. A Typical Concentrating Mill. Ill. E. H. Davies (M J–Oct. 6.) 1000 w.

*25950. The Copper Prospects of New South Wales. Editorial (M J–Oct. 6.) 700 w.

26067. Centrifugal Mine Ventilators. Ill. R. O. Jones (A M & I W–Oct. 19.) 3000 w.

26110. The Phosphates of Tennessee. Ill. Thomas C. Meadows and Lytle Brown (E M J–Oct. 20.) 1300 w.

26111. The Development and Future Prospects of Mining in Arizona. John F. Blandy (E M J–Oct. 20.) 1800 w.

26113. Ballarat. T. A. Rickard (E M J–Oct. 20.) 1000 w.

26114. Copper Deposits on the Kirghiz Steppes, Siberia. Ill. (E M J–Oct. 20.) 1100 w.

*26117. Structure of the Hainaut Coal Basin (Extract.) M. A. Briart (C G–Oct. 12.) 6000 w.

*26120. The Coalfields of Labuan, Borneo (Abstract.) Robert Fisher (C G-Oct. 12.) 1800 w.

†26156. Redonda and Its Phosphates. Fred W. Morse (P S M–Nov.) 4400 w.

26177. The Los Angeles Oil Developments (M S P–Oct. 20.) 1200 w.

*26227. Automatic Moving of Tubs at the Anzin Colliery. Ill. (C G–Oct. 19.) 2800 w.

26239. The Mine Fire at Packer No. 5 Colliery. Ill. Baird Halberstadt (A M & I W–Oct 26.) 3600 w.

*26258. New Gold Fields in South Africa. Editorial (M J–Oct. 20.) 900 w.

26292. The Sabinas Coalfield. Ill. E. G. Tuttle (E M J–Oct. 27.) 2500 w.

26297. The Use of Steel Beams in Mines. Ill. (I T R–Oct. 25.) 500 w.

*26318. Indian Mineral Production (B T J–Oct.) 1000 w.

*26335. The Aerial Rope or Cableway System of Transport as Applied to the Development of the Coal Fields of Victoria (A M S–Sept. 22.) 2000 w.

*26337. South Australian Goldfields (A M S–Sept. 22.) 900 w.

*26340. The Gold-Bearing Formation of the Thames (N. Z.) J. Parke (A M S–Sept. 29.) 2000 w.

26384. Gold in the South. Henry V. Maxwell (T–Nov. 1.) 2500 w.

26390. Placer Diggings of the Cape Horn Country (Min R–Oct. 25.) 1500 w.

26412. Mining in British Columbia. Robert C. Adams (C M R–Oct.) 3000 w.

26413. Slate: Its Formation, Extraction and Uses. H. J. Williams (C M R-Oct.) 3500 w.

*26452. Experiments with Explosives for Mining Purposes (C G-Oct. 26.) 8000 w.

26523. Gold Mining in Ecuador. A. F. Saabye (E M J-Nov. 3.) 1300 w.

*26543. The Quarries of Jerusalem. O G. Woods (A L-Oct. 26.) 1700 w.

26565. Origin and Formation of Gold Veins (Min R-Nov. 1.) 1800 w.

*26568. Prevention of Roof Falls. Ill. Joseph Hemingway (C E-Nov.) 4500 w.

26581. Production of Potash Salts in Germany (E M J-Nov. 10.) 1700 w.

26582. The Waste Dump of the Havre Coal Mines, Belgium. Ill. Adolph Demeure (E M J-Nov. 10.) 700 w.

26584. The Deep River Coalfield of North Carolina and the Egypt Coal Company's Plant. E. G. Tuttle (E M J-Nov. 10.) 1200 w.

26585. The Australian Mining Laws. T. A. Rickard (E M J-Nov. 10.) 800 w.

26607. The Sydney Coalfield of Cape Breton, Nova Scotia. Hugh Fletcher (Sc A S-Nov. 10.) 2400 w.

*26645. The Goldfields of West Australia.—Interview with C. A. Moreing (Min W-Oct. 20.) 2800 w.

*26646. What Is the Position of the Consolidated Goldfields of South Africa? (Min W-Oct. 27.) 1000 w.

Miscellany.

25775. Reminiscences of John Fritz.—Address to the Mining Engineers (Ir Age-Oct. 11.) 6500 w.

25806. Measurement by Miner's Inch (M S P-Oct. 6.) 1700 w.

*25818. Quincy Granite and Its Manufacture. Ill. (S-Oct.) 3000 w.

†25962. The Eight-Hours' Bill for Miners.—Its Economic Effect. Emerson Bainbridge (C R-Oct.) 6800 w.

25992. Chief Sources of Aluminum. C. W. Hayes (Sc A S-Oct. 20.) 1650 w.

26204. The Bronze Age in Europe. William H. Knight (Sc A S-Oct. 27.) 2800 w.

26264. The Pullman Foundries. Ill. John T. Bramhall (F D-Sept.) 1800 w.

*26451. Electric Haulage in Mines. Joseph Libert (C G-Oct. 26.) 4800 w.

*26454. Notes on the Manufacture of Coal Briquettes, as Carried on in France in 1872. William Pole (C G-Oct. 26.) 1000 w.

26579. Mining and Railroading Within the Arctic Circle. P. T. Lidner (E M J-Nov. 10.) 2000 w.

Serials.

20413. Mining Methods. Ill. (C E-Began March—9 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—9 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—9 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—9 parts to date—30 cts. each).

21369. Press Work of Sheet Metals. Ill. Oberlin Smith (Ir Age-Began April 19—Ended Oct. 18—9 parts—15 cts. each).

21814. Plate Moulding. Ill. J. Horne (P Eng-Began April 27—9 parts to date—30 cts. each).

23207. The Origin and the Mode of the Formation of Coal. Adolph Firket (C G-Began June 22—7 parts to date—30 cts. each).

23685. Calculating Weights for Estimates. Ill. J. Horner (A M-Began July 19—4 parts to date—15 cts. each).

24036. Metal Mining. Albert Williams, Jr. (C E-Began Aug.—3 parts to date—30 cts. each).

24075. Manufacture of Tin-Plates (I & I-Began July 27—4 parts to date—30 cts. each).

24362. Methods of Mine Timbering. Ill. (M S P-Began Aug. 11—Ended Oct. 6—5 parts—15 cts. each).

25384. Rustless Coatings for Iron and Steel. M. P. Wood (A M-Began Sept. 27—3 parts to date—15 cts. each).

25572. Mineral Resources of the United States. John Birkinbine (M J-Began Sept. 22—4 parts to date—30 cts. each).

25689. A Typical Gold Mine Region.—Cripple Creek, Col. Ill. Arthur Lakes (C E-Began Oct.—2 parts to date—30 cts. each).

25980. The Casting Temperature of Soft Steel (Ir Age-Began Oct. 18—2 parts to date—15 cts. each).

26017. The Genesis of Gold Placers (M S P-Began Oct. 13—2 parts to date—15 cts. each).

26031. European Phosphates. C. C. Hoyer Millar (M R-Began Oct. 19—4 parts to date—15 cts. each).

26118. Iron Ores. John Randall (C G-Began Oct. 12—3 parts to date—30 cts. each).

26139. Aluminum. A. Humboldt Sexton (P Eng-Began Oct. 12—1 part to date—30 cts).

26145. The Mining Districts of Coolgardie (W. A.) (A M S-Began Sept. 15—2 parts to date—30 cts. each).

26256. Some Notes on Persian Mining and Metallurgy. (Extract.) James Mactear (M J-Began Oct. 20—Ended Oct. 27—2 parts—30 cts. each).

26293. The Zinc Mining Industry of Southwest Missouri and Southeast Kansas. J. R. Holibaugh (E M J-Began Oct. 27—3 parts to date—15 cts. each).

26386. Proper Foundry Construction and the Apparatus to Be Used. Simpson Ballard (T-Began Nov. 1—1 part to date—15 cts).

26496. Construction and Working of Regenerator Settings of Retorts. W. R. Chester (A M & I W-Began Nov. 2—1 part to date—15 cts).

26556. The Phosphates of the World. Francis Wyatt (J F I-Began Nov.—1 part to date—45 cts).

26561. The Cornwall Ore Hills. John Birkinbine (Ir Age-Began Nov. 8—I part to date—15 cts).

MUNICIPAL ENGINEERING

Public Ownership of Gas Properties.

MR. WALTON CLARK, in a paper published in the *American Gas Light Journal* (October 29), makes an able argument against municipal ownership of gas works. The argument is in the nature of a reply to arguments contained in two monographs, to wit, "The Relation of the Municipality Ownership to the Gas Supply," by Prof. Edmond J. James, Ph. D., (University of Pennsylvania), and "Municipal Ownership of Gas in the United States," by Prof. Edward W. Bemis, Ph. D. (Chicago University). Professor James advances the proposition that the burden of proof lies on the opponents of public ownership. Mr. Clark regards the true and necessary functions of municipal authority to be the following: "Provision and maintenance of public improvements, *i.e.*, pavements, parks, sewers, public buildings, etc., and exercise of the police power; the latter covering the protection of the health and peace of the community, and the property of the citizens. Its business is to protect property and person, leaving to individuals all the liberty compatible with this protection. Municipalities are purely artificial. Being formed to aid and protect men in the legal exercise of their various talents, they should not assume any function that it is not clearly evident cannot be performed by individuals or associations of individuals without harm to the general interest. The assumption by a municipality of any function that can be performed by individuals is thus an interference with the natural order that demands a complete demonstration of public advantage for its justification; therefore the contrary of Professor James' proposition is true and the burden of proof is on the advocates of public ownership."

Professor James, speaking for himself and other advocates of municipal control, makes the following propositions:

"1. Public ownership is the natural system in all cases of necessary monopolies.

"2. Gas distribution involves occasional disturbance of the surface of the street. The streets are the proper care of the municipality, and, therefore, any business involving their disturbance should be controlled by the municipality.

"3. As a large consumer of gas in street lighting, the city has an interest in gas manufacture that justifies it in establishing municipal works.

"4. Public ownership of industries tends to purity and efficiency in the management of public affairs.

"5. Gas companies are oppressive in their charges, their product is inferior and their function can be better and more cheaply performed by the municipality."

The reply denies that gas is a prime necessity as is water supply. So far is this statement from being true that in the city of Wheeling where gas was sold at 75c. per 1000 cubic feet, there were in 1891 less than 3500 premises consuming gas in a population of 40,000. About one-half of the residences of Wheeling were lighted by other means than gas. The development of the electric light is also gradually reducing the demand for gas, and has already very largely reduced it. "Pure water is the prime necessity to comfort, health, and even to life. There is no substitute for it. No question of economy or choice enters into the matter. Every man must have it and the need will perish only with the race. The only point common to water and gas supply is that each is taken by the user as wanted from an opening upon his own premises, the openings being connected to a common store through pipes laid in the streets."

If on account of disturbance of streets and pavements gas companies ought to be owned by municipal corporations, so also should street railway, electric, telephone and pneumatic tube enterprises. It is denied that cites have such an interest in gas lighting as justifies ownership. In many of the large American cities electric lighting is now substituted for gas, and this substitution is annually increasing and extending even to small towns.

That public ownership tends to purity and efficiency in administration of public affairs, is, in the light recently shed upon the manner in which the people have been robbed by city governments, so palpably absurd, that it seems hardly necessary to be refuted. Yet to it a conclusive answer is found. "If corruptible men are in charge of our public affairs, a change from private to public, or from public to private ownership merely changes the form of the temptation to corruption. The one means to purity in public as in private business is purity in the men intrusted with its conduct. Dishonesty found its opportunity before Stevenson or Murdock were born, and cannot be deprived of it by a change of ownership of railroad or gas properties."

As to renewal of oppressive charges and cheaper manufacture by municipalities it is answered that "A municipality may reasonably exact from the gas company valuable concessions in return for assured exemption from gas competition. Such an arrangement insures the maximum of advantage to both municipality and company. A number of admirable systems are in actual operation." The idea of a revenue from the sale of gas is denounced as directly repugnant to all ideas of equity. "Municipal works being run as their advocates generally say they should be, for the purpose of cheapening gas, the gas must in equity be sold at its cost, including interest, charges, etc., the city paying the gas works account for all the gas used for public illumination." As to interest on money borrowed for the erection or purchase of works, the city as a borrower would have no advantage over a private company guaranteed against competition.

Professor Bemis cited the city of Wheeling as "the most conspicuous example of success in municipal ownership." The facts are that in Wheeling gas sells for 75 cents per thousand cubic feet. According to the books, it costs 43.7 cents delivered to the consumer. The depreciation, interest for taxes, must be included in a statement of actual cost. Mr. Clark accepts Prof. Bemis' estimate of depreciation as 2 per cent. Taxes are 1.2 per cent. These are estimated upon the structural value of the plant, which Prof. Bemis states was $380,000.

"Interest must be figured on the investment, sworn to by the superintendent at $800,000. With the entire credit of the city of Wheeling as security, its bonds bear interest at from 4½ per cent. to 6 per cent; 5 per cent. would be certainly within bounds for gas works bonds." The sum of these various charges amount to 45.1 cents per thousand cubic feet and it is clearly shown that when this is added to the actual cost of the gas, the latter costs about 14 cents per one thousand cubic feet more than Wheeling gets for it.

Irrigation by Sewage.

THE city sewage of Trinidad, Colorado, is disposed of for irrigation of arid districts in the neighborhood. This is the first attempt of the kind yet made in that state and a description of it is given by Mr. Norvel W. Wall, in the *Annual of the American Society of Irrigation Engineers* for 1892-93, recently issued.

The question of this kind of sewage disposal was under consideration during a considerable period prior to its adoption. When "the accumulation of filth became an unbearable nuisance," it was at first proposed to discharge sewage into the Las Animas river which runs through the city. This is a comparatively small stream, and as farmers below the city are obliged to resort to it for supplies of potable water, the idea of making it a vehicle for the sewage of the town was abandoned. Mr. Wall having been appointed advising engineer of "a committee with power to report a practicable system of sewage," made the necessary plans and sewage for the irrigation systems. In his report he said:

"Irrigation by sewage means the application of liquid sewage to the lands with the view of intercepting the fertilizing constituents. We all know the necessity of irrigating for the production of crops in this section of the country. In order to utilize the sewage for this purpose, it would be obligatory on you to procure a farm some distance below the city, where the sewage could be conducted and there utilized, or the city could make contracts with one or more farmers to receive the sewage from the city. In my opinion, it would enable them to raise large crops and thereby constitute a revenue and not a tax. This method prevails both in England and continental Europe, and has been found to be practicable, and in many cases a financial success."

The system having been thus strongly recommended to the committee, as a complete solution of the problem of sewage disposal for the city of Trinidad, it was adopted ; but a serious obstacle was met at the outset. "The plan appeared to the western farmer to be an innovation, and it seemed impossible to make a contract for any reasonable price, no one wishing to experiment with what was feared would become a difficult undertaking." In this emergency "Hon. James M. John, then mayor of the city, agreed to take care of the sewage for five years," and the scheme was carried out under this contract.

An outlet sewer conveys the sewage to the lands of Mr. John. This is constructed of eighteen-inch vitrified sewer pipe laid to a grade of two-tenths of a foot per hundred feet, or 10.56 feet to the mile ; the sewer having a velocity of 2.58 feet per second when running full. The Las Animas river is crossed by an inverted syphon under the river bed made of 16-inch cast iron water pipe, having a masonry catch basin at either end. This syphon has a velocity of 4.68 feet per second when running full, a high velocity being necessary to keep the syphon from choking. A masonry chamber or tank is constructed at the mouth of the outlet sewer, and from thence the sewage is conducted to the several basins or reservoirs constructed by Mr. John. The lands are well situated for the purpose of irrigation ; sloping toward the south and the Las Animas river from 2.5 feet to 3.5 feet in one hundred." These lands have been terraced and the sewage is conducted from the higher levels or terraces to the lower through wooden sluice-boxes, and the entire tract will be seeded to blue grass. "The sewage system will have, when completed, automatic flushers at the head of each lateral. The sewage is well diluted by the time it reaches the outlet, very little solid matter remaining.

"An obstacle to this plan in the eastern states and northern Europe, is the water contained in the sewage, these countries having already sufficient moisture for their crops, in some places the water being so plentiful that it is necessary to adopt a system of subsoil drainage to conduct away the surplus water. On the contrary, the object of the western farmers is to retain all the water possible. The objects of the states and countries using this system are a sanitary measure, and fertilizing the land. In the west we not only get rid of what would otherwise prove a detriment to the health of the community, and perhaps the pollution of our streams, but also gain an amount of water that would otherwise be lost, particularly in the season when our natural streams are at their lowest."

It is expected that when the system thus inaugurated has been completed it will bring into cultivation a large tract of land that has hitherto been unproductive.

Essential Qualities of Paving Brick.

An article from the *Clay Worker* (London, Oct.) reprinted in *Paving and Municipal Engineering*, calls attention to defective specifications for brick pavements. A common specification is that "the brick must be hard, free from defects of any kind, manufactured and burned especially for street paving purposes, equal in all respects to the sample filed with the proposal, and subject to inspection, acceptance, or rejection by the engineer or inspector.

"With our present knowledge of this material, this phraseology may be accepted, but in reality it specifies very little. Its acceptance or rejection by an engineer is ordinarily regarded by the corporation as a safeguard, but no parties entering into a contract can place a power that is wholly arbitrary and undefined in the hands of an engineer, who is in reality the executive agent of one of the parties. Because bricks have been manufactured and burned especially for street paving purposes, it does not necessarily fit them for such use. The term 'hard' is an indefinite one, and without stating what constitutes defects, there may be differences of opinion as to whether or not they exist in a given article, as well as to the equality of goods furnished with sample exhibited. Even sample paving bricks have been known to be worthless for street paving. The characteristic qualities and strength of the material are not clearly set forth as they should be. The power to accept or reject is left undefined, which should never be the case; neither manufacturer, bidder, nor taxpayer should be bound by the action of an engineer, unless that action shall be in accordance with known provisions and fixed rules."

The fault in specifications for street paving materials here pointed out is general in specifications for other kinds of municipal work, and specifications that do not specify are common enough in all kinds of contract work, whether in municipal or other departments of engineering.

It is not deemed advisable to specify ingredients too definitely on account of the wide variations in clays from which good paving bricks can be made. What ought to be definitely specified are the qualities required. However, the presence of lime can be readily detected, and specifications may properly exclude lime. The quality of absorbing water ought to be limited to the lowest point that can be specified without exclusion of bricks known to be otherwise good. Two per cent. is the maximum absorption that should be allowed. Minimum specific gravity ought to be as high as 2.1, "with credit for excess"; and a suitable maximum would be 2.3. Crushing strength should not be less than "12,000 pounds per square inch." Modulus of rupture, as determined by tests of transverse strength "could be properly fixed at 1600." In abrasion tests the loss of weight by the brick should not be more than 2.25 times that of hard granite.

"Uniformity in size and texture appears to be attainable, and lack of it produces many undesirable difficulties. Wide variations in size result from faulty drying and burning. We must either specify how the drying of the brick and the firing of the kiln shall be done, or describe what we want as the product of the kiln, and insist upon getting it. In the present state of our knowledge, the safer plan will be to name the requirements, and leave the manufacturer to wrestle with the details."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

*25785. Mr. George Livesey on the Inception and Development of Gas Lighting, with Editorial (J G L–Oct. 2.) 8000 w.

*26027. Inaugural Address of Colonel Sadler (J G L–Oct. 9.) 4000 w.

*26028. The Price of Gas in London.—Important Conference of Vestrymen (J G L–Oct. 9.) 3200 w.

26200. The Invention of Water Gas. Ill. (Sc A S–Oct. 27.) 1000 w.

26240. Products of Combustion from Argand and Welsbach Burners (A M & I W–Oct. 26.) 600 w.

26288. Regenerative Benches. A. E. Forstall (A G L J–Oct. 29.) 3000 w.

26289. Public Ownership of Gas Properties. Walton Clark, with Discussion (A G L J-Oct. 29.) 6000 w.

26455. Observations on Sunday Methods of Making Water Gas from Bituminous Coal. Ill. Mr. Egner, with Discussion (A G L J–Nov. 5.) 5500 w.

*26507. A Contribution Towards the Statical Calculation of the Guide-Framing of Independent Gasholders. Ill. M. Niemann (J G L–Oct. 23.) 4000 w.

Sewage.

25845. The Wentworth Avenue Trunk Sewer, Chicago, Ill. (E N–Oct. 11.) 1700 w.

*25917. The Pollution of the Aire and the Calder. Editorial (E–Oct. 5.) 2700 w.

*25924. The Utilization of Town Refuse for Generating Steam. (Abstract.) T. W. Baker, with Discussion (I & I–Oct. 5.) 2200 w.

†26074. Utilization of Sewage for Irrigation Purposes. H. I. Reed, with Discussion (A S I E–1892-93.) 2000 w.

*26213. Manchester Main Drainage. Ill. William Thomas Olive (E–Oct. 19.) 6000 w.

26394. The Merz System of Garbage Utilization in Four American Cities. Ill. (E N–Nov. 1.) 9500 w.

*26426. Brussels' Sewage System. Ill. Gibson Thompson (P–Nov.) 3500 w.

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The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

26625. The Paris Sewers and Sewage Farm. William P. Mason (E N–Nov. 8.)600 w.

Streets and Pavements.

*25279. Street Paving in Sheffield (B A–Sept. 7.) 1800 w.

25846. Property Assessments for Street Improvements. Editorial (E N–Oct. 11.) 2000 w.

25860. Street Paving in Western Cities (E R–Oct. 13.) 1800 w.

26001. Street Paving and Watering in Boston in 1893 (E N–Oct. 18.) 1100 w.

*26034. Asphalt Pavements. S. Whinery, with Discussion (J A E S–Sept.) 10000 w.

26279. Specifications for Roads and Sidewalks, Boston Public Parks (E R–Oct. 27.) 1000 w.

*26391. Cleaning the Streets of Paris. Henry Smith Williams. (From Harper's Weekly.) (C A–Oct.) 3200 w.

*26425. Cohesive Strength of Asphalt. F. N. Speller (P–Nov.) 900 w.

*26428. Essential Qualities of Paving Brick (P–Nov.) 1800 w.

Water Supply.

25798. The New Croton Dam on the Cornell Site. Ill. (Sc A–Oct. 13.) 1600 w.

25843. New 30,000,000—Gallon Pumping Engines, Philadelphia Water-Works. Ill. (E N–Oct. 11.) 900 w.

25947. Filter at the Wannacomet Water-Works, Nantucket, Mass. Ill. (F. W–Oct. 13.) 1600 w.

26003. The Dunning's Dam, Scranton, Pa. E. Sherman Gould (E N–Oct. 18.) 1800 w.

*26036. Covered Reservoir at Rockford, Ill. Ill. Charles G. Stowell (J A E S–Sept.) 2000 w.

*26052. The Leicester Water "Famine" (E–Oct. 12.) 4000 w.

26064. Delaware River Water for Philadelphia, Pa. (E R–Oct. 20.) 800 w.

26065. Test of the Louisville Pumping Engine. Ill. (E R–Oct. 20.) 3500 w.

†26121. The Hesserghatta Water–Supply. Ill. R. T. S. (I E–Sept. 22.) 1700 w.

26179. Manchester Corporation Water-Supply. The Inauguration of the Thirlmere Works (J G L–Oct. 16.) 3800 w.

†26231. The Quality of Water Supplies. William P. Mason (J A C S–Nov.) 1200 w.

25259—$1. Frontinus and His Two Books on the Water Supply of the City of Rome (A E C U–1894.) 16000 w.

26276. The Water Supply of Two Cities. John W. Hill (E R–Oct. 27.) 1900 w.

26278. Sing Sing, N. Y., Water-Works. Ill. (E R–Oct. 27.) 1600 w.

26327. Electrolyzed Water Pipes in Omaha. Joseph Rigge, Sr. (F W–Oct. 27.) 1700 w.

26348. The Water Supply of New York City.—The New Carmel Dam and Reservoir. Ill. (Sc A–Nov. 3.) 1000 w.

*26445. The Thirlmere Water Supply. Ill. G. H. Hill (E Rev–Oct. 20.) 900 w.

26479. The Water-Works of Naples (A A–Nov. 3) 900 w.

*26515. Water Supply. Henry Robinson (Eng L–Oct. 26.) 1300 w.

†26531. The Pollution of Water Supplies and the Results of Filtration.—Report of Committee. Charles Smart, Chairman (San–Nov.) 5000 w.

26608. The New Dam for the Chemnitz Water Works. Ill. (Sc A S–Nov. 10.) 450 w.

26612. Report on Duty and Capacity Trial of Worthington Pumping Engine at Low Level Pumping Station, Montreal Water Works. J. T. Nicolson and J. Emile Vanier (C E N–Nov.) 1400 w.

Miscellany.

*26033. Typhoid Fever and the Epidemic at Ironwood, Mich., in 1893. E. A. Rudiger (J A E S–Sept.) 5000 w.

*26100. Sanitation in Liverpool. Presidential Address of G. F. Deacon. (Abstract.) (A L–Oct. 5) 2500 w.

†26157. The Chemistry of Cleaning. Vivian Lewes (P S M–Nov.) 5800 w.

†26499. Excavation and Disease (I E–Sept. 29.) 500 w.

*26517. The Disposal of Town and Other Refuse. Ill. James Deas (E E L–Oct. 26.) 1500 w.

26626. The Proposed Drainage System for New Orleans (E N–Nov. 8.) 1800 w.

Serials.

23641. Details of Rural Water Supply (B–Began July 7—17 parts to date—30 cts. each).

24751. The Gas Manager Abroad (G W–Began Aug. 25—7 parts to date—30 cts. each).

25117. Remarks on the Gas Industry in America. H. Bunte (P A–Began Sept. 15—Ended Oct. 15—3 parts—15 cts. each).

25179. The Water Service and Fire Protection of Theatres. William Paul Gerhard (F W–Began Sept. 15—Ended Nov. 3—8 parts—15 cts. each).

25347. About Water Gas. Edwin A. Doron (G E M–Began Sept.—2 parts to date—30 cts. each).

25898. Oil Gas. W. A. Noyes, W. M. Blinks and A. V. H. Mory (A M & I W–Began Oct. 12—2 parts to date—15 cts. each).

26096. Notes on Modern Gas Making Plant (I & I–Began Oct. 12—2 parts to date—30 cts. each).

26221. The Manchester Thirlmere Water-Works. Ill. (Eng L–Began Oct. 19—1 part to date—30 cts).

26436. Gas Manufacture. J. J. Johnson (C T J–Began Oct. 27—1 part to date—30 cts).

We supply copies of these articles. See introductory.

RAILROADING

Reasonable Railway Rates.

A PAPER occupying 26 pages, with numerous tables of statistics chiefly compiled from the Reports of the Interstate Commerce Commission, by H. T. Newcomb, appears in the *Annals of the American Academy of Political and Social Science* for November. The purpose appears to be to correct in the minds of the public some erroneous views prevailing with reference to railways, and to show not only that the tendency of rates has been, and is downwards, but that this must continue until the level of reasonable rates is everywhere reached.

"There is great danger of forgetting, at least temporarily, that the only adequate cause for the prevailing widespread dissatisfaction with the methods adopted by those officially in charge of railway properties, and the relations between railway corporations and their patrons is public discontent resulting from the charges exacted for railway transportation. Railway men are perhaps sometimes justified in the use of the term 'confiscatory legislation' even as applied to what 'are in reality honest, although often mistaken, attempts to secure to the public by legislative action more satisfactory rates.' Many statutory regulations have not only failed of good effect, but have absolutely wrought evil.

"Upon the other hand, an important section of the press and many popular leaders are constant and vehement in their attacks upon the so-called evils of over capitalization, stock watering, unnecessary construction, improvident and wasteful management, consolidations, agreements to maintain rates or divide traffic, etc., which, even if serious evils in themselves, can only operate injuriously upon a limited number of individuals, unless their effects extend to the charges for transportation."

"Popular dissatisfaction with railway charges does not arise from the fact that they are universally or even generally excessive. Railway rates in the United States are generally lower than anywhere else in the world, much lower than they were here five, ten or fifteen years ago, and quite as low as is consistent with the maintenance in an efficient condition of road-bed and equipment, the payment of fair wages, and even approximately adequate return to the capital invested."

The reduction of rates during the six years of operation of the interstate commerce law, are stated to have saved the public during the year ending June 30, 1893, no less than $149,405,511, "an amount exceeding by nearly $50,000,000, the total of all the dividends paid on railway stock, and equal to seventy-three per cent. of the entire customs revenue of the United States government during that year."

Mr. C. C. McCain, auditor of the Interstate Commerce Commission, is quoted as asserting that "from all forms of comparison presented, it is clearly demonstrated that there has been a constant downward tendency in freight charges in all sections of the country." A statement of rates charged for transportation of grain by all lines from Chicago to New York, confirms the assertion of Mr. McCain.

RATES IN CENTS PER 100 POUNDS.

Year	Jan. 15.	April 15.	July 15.	Oct. 15.
1864		75	80	95
1869	75	50	50	50
1874	60	40	45	45
1879	35	20	22	35
1884	30	15	20	25
1889	25	20	20	25
1894	25	20	20	25

In 1873 it cost $4.05 per gross ton to transport coal from the Clearfield region of Pennsylvania to Jersey City; whereas it now costs $2.25. In 1881 it cost 74 cents per bale to transport cotton from Memphis to New York; last year the rate was constant at 50½ cents. Whereas freight upon starch from Boston to North Adams was 38 cents per 100 pounds in 1874 (Boston and Albany railroad), it is now 15 cents. This last is cited as indicating that local rates have in many instances declined in greater proportion than competitive rates ; it is not a solitary instance.

"Examples of reduction equal in extent to the foregoing, including all sections of the country and every article of commercial importance commonly offered for shipment by rail, might be multiplied indefinitely." This tendency toward lower rates is thus proved to have been a marked characteristic of railroading in the United States.

When the cause for this reduction is sought, it is implicitly, if not explicitly denied that it has been "grudgingly yielded by reluctant carriers who have succeeded in retaining rates sufficiently high to yield extortionate and unreasonable returns upon the capital invested." As opposed to this view, stands the principle that only in exceptional and rare cases is it possible to maintain excessive rates.

"The interest of the railways and their patrons both unite in the creation of conditions against which it is vain for any railway official to contend for extremely high rates." High rates may be carried to a prohibitive extreme, and the law of competition acts with railroads as in all other kinds of business. "A large traffic at low rates is often more profitable than a smaller traffic at higher rates." Low rates promote industrial development along lines of railway, and this reacts upon the roads to increase their business. "An enlightened consciousness of these facts has caused the great majority of railway officials, having authority to make rates, to concede to their patrons the lowest rates that could be made without increasing expenses faster than gross revenue." The average financial condition of the roads also proves that they have not been able to exact excessive rates. Sixty per cent. of their aggregate revenue is required to pay cost of operation, including wages, repairs of road-bed, equipments, etc., three per cent. is paid in taxes, leaving only "twenty-seven per cent. to be distributed among those who furnish capital, for use in making permanent improvements, and surplus for future contingencies." Tables of receipts and expenditures, carefully compiled, prove this fact.

As to watered stock, it is held that "instances of substantial reduction of capitalization resulting from mortgage foreclosures, are numerous enough to create considerable confidence that they may entirely balance the water. . . During a period of eighteen years, from the beginning of 1876 to the close of 1893, 551 railway corporations, operating 57,283 miles of road, with stocks and bonds amounting to $3,209,126,000 were sold under foreclosure. This tremendous insolvency with resultant sales under the hammer of the auctioneer may easily have resulted in wiping out an amount of stocks and bonds little, if any, less than that created by watering."

But while it appears that railway rates are not excessive, the unjust discrimination in rates which has found its way into railway transportion, is deleterious to industrial prosperity, and this more than anything else, or all else put together has raised the popular outcry for legislation regulating traffic. The aggregate rates not creating excessive revenues to the roads, there are still unjust and inequitable conditions which must be removed to satisfy the reasonable demands of the public. The conclusion is thus reached that it is quite as important "that the adjustment of rates shall be made without unjust discrimination against persons, places, or classes of traffic, as that the charges shall not be excessive. . . Reasonable and proper discriminations, based upon the value of service performed, are essential and should continue." The carrier's revenue should be made "the sole criterion of charges, subject to the single limitation that rates must be open to all."

Responsibility for Joint Tariffs.

THE recent order of the Interstate Commerce Commission is made the subject of editorial criticism in *The Railway Review* (Oct. 13), or, more strictly, the reasons assigned by the commission for promulgating the order are considered as defective and unsatisfactory. This view is more particularly taken of the following clause, relative to joint tariffs.

"When such a tariff is filed by one of the associated lines only, as is usually the case, if the participating carriers are not designated and no proof of their concurrence is furnished, it is quite possible for the latter to avoid liability when charged with criminal misconduct in respect of a joint rate so issued, by denying knowledge of its existence or consent to its publication, although the fact that they carried traffic apparently under that tariff may be clearly established. If a connecting carrier, which joins in the transportation of freight received from the initial carrier is prosecuted for violating the joint rate published by that initial carrier alone, there can be no conviction without proof, often impossible to obtain, that such connecting carrier agreed to the joint rate in question or authorized its promulgation. On the other hand, if it is assumed that the connecting carrier is not a party to the joint rate so issued, for want of assent thereto or concurrence therein, and the charge of unlawful conduct is based upon the acceptance of less than its own local tariff, such connecting carrier may refute the accusation by asserting that it had consented to the joint schedule issued by an initial carrier, and was in fact a party thereto. Thus the ground of defense can be shifted to meet the theory of the prosecution, and a given carrier actually guilty of wrongdoing may secure immunity from punishment through inability to determine, before its disclosure is forced, whether it is or is not bound by the joint tariff which another carrier has published and filed."

Of this the opinion is expressed, that "while it is important that the identity of parties to a joint tariff shall be susceptible of proof in court, it is not clear that under the decision of the commission such a condition will be established." The assumptions of the commission "that the carrier which publishes a tariff of this kind would ordinarily send copies of the same to all other carriers expected to participate in the joint service thereby announced" and "that it must be entirely feasible for the carriers receiving such a tariff to forward to the commission official notice that they consent thereto," are regarded as incorrect. The Wabash road is instanced in this connection as the one on which "the very difficulty sought to be removed by the order in question was experienced."

"The Wabash road may issue a tariff from East St. Louis to various eastern points. This tariff is not issued for the purpose of advising its connections of the rates under which property is to be carried, nor is a copy of it as a rule, if ever, sent to even its immediate connections, to say nothing of subsequent carriers. It is issued as an advertisement pure and simple, and is designed for distribution among its patrons. The document so issued in the sense that it determines the rate is of no force whatever. It is simply an advertising notice to the public of what the rate is, of a character identical with any other advertisement, the same as if published in the advertising columns of a newspaper. The advice to participating lines as to rates in effect is conveyed to them in an altogether different way, and not by the Wabash road at all, although that road would expect and would be justified in expecting that any line participating in the business would accept its proportion of the current rate without any direct notice from itself."

Another assumption of the commission disputed is that "such tariffs necessarily imply an agreement between two or more carriers by virtue of which they offer their united services at the rates therein named" also the assertion is made in this connection that these agreements are not made in writing but that they "almost invariably rest in parole." On the contrary, it is asserted on the part of the *Review* that so far from contracts for interchange of business being usually in the nature of parol agreements, they are made in writing, and "are usually arranged with the utmos care and particularity."

A caution is given to those who entertain the idea that no penalty can attach to the failure of a road to comply with th order. "A writ of injunction to restrain from receiving or transporting property any common carrier who shall neglect or refuse to file or publish its schedule of rates, fares or charges, as provided for in section six, may be served upon roads which do not meet the requirements, and the same section also provides that the commission "may determine and prescribe the form of schedules." In view of all aspects of the question it is advised that "the roads make a sincere attempt to comply with the requirements and rely upon the admitted fairness of that body to reconstruct its order as soon as it shall be found that the present regulation is not effective."

The Permanent Way of the Pennsylvania Railroad.

"ENGINEERING" (London) in its issue of October 26 has published a long article on the above named subject, in which not only the general character of the permanent way is considered, but its details are gone into with abundant illustrations. A very high encomium upon the engineering management of this great road is bestowed.

"Although at the present time there are not a few railways in the United States for which may be fairly claimed a place in the front rank, even when judged by the highest standard, for efficiency in construction and for equipment, it will, we suppose, be freely recognized that it was the Pennsylvania Railroad Company which initiated the progress that has converted the railway system of America from being a rough and somewhat unready means of transport to the high-class system that it is to-day. From its earliest days—and the organizers of this now great and powerful company were among the pioneers of railway construction in America—the motto of the Pennsylvania railroad has been "Advance." Nearly twenty years ago we published in these columns a long series of articles, from which the English readers learnt for the first time what was the most advanced railway practice of the period in the United States. Were we again to undertake a similar task we should once more select the Pennsylvania railroad as our type of the highest development, for we consider that it has in all respects maintained the lead which energy and skill secured for it at least half a century ago."

Not only the details of the permanent way, but the business methods of the engineering department in getting work and materials up to their present high standard are favorably considered. The standard specification for steel rails is an exemplification of these methods. Probably nothing more thorough in the way of specifications exists. Every structural, physical and chemical quality desired is so explicitly stated that no chance for any disagreement as to the meaning of each requirement can be made by manufacturers who undertake to supply the rails. There are ten clauses specifying these requirements, four which state defects that will cause temporary rejection, and four which state causes for permanent rejection. Standard rail-sections are illustrated with dimensions of flange, web, and head.

Specifications for road-bed, ballast, cross-ties, line and surface of track, joints, gage, switches, sidings, ditches, and road crossings, have all been prepared with equal care and minuteness. The numerous diagrams of details together with the descriptive text form an exposition of one of the best existing examples of general railway practice, of technical value to railway engineers and others in any way connected with the construction and maintenance of railways.

A Dynamometric Car.

ON the Western of France Railway is what is called a dynamometric car of which *The Engineer* (London) has given an illustrated description. This car well exemplifies the refinement of modern engineering methods in testing the action of machines. By its use the tractive effort, total work, speed, number of revolutions of wheels, time of running, distance run, etc., are determined, which, together with the weight of fuel consumed, ascertained by weighing, water evaporated, which may also be determined either by weighing or measuring, and an analysis of the products of combustion, constitute a complete set of data for determination of the mechanical and economical efficiency of any locomotive to which the dynamometric car is attached.

"The car is carried upon two axles and a special coupling arrangement is employed to eliminate the influence of curves while permitting the buffers to make contact; for this purpose the buffers are connected to a transverse bar which rests at the center upon a group of rubber washers. Upon the platform at the end of the car a trap door is arranged, so that the dynamometer may be readily put in or out of gear. At each side of the entrance door is a raised seat, from which an attendant can observe the train, track, and locomotive, and have within reach electric press buttons to note upon the diagrams particular points upon the roads, also a speaking tube to the locomotive, and apparatus for the purpose of collecting gases from the chimney. Under the seats are arranged the Orsat apparatus for gas analysis.

"Outside the end windows are placed inclined plates to prevent the deposit of dust and soot upon the glass. In the center of the car is placed a table, upon which are collected all the recording apparatus described below. At one end of the vehicle there is a lavatory, and also a workshop in which any slight necessary repairs may be done while traveling. The car is heated by means of a small stove, and ventilation is assured by means of two Pignatelli apparatus, one opening above the end windows and the other in the ceiling of the central compartment. The results obtained in each particular trial are all recorded upon a single band of paper which receives its motion from the axle of the car, and is unrolled continuously during the journey proportionally to the distance covered. All the recording apparatus also is put into action by the car itself.

The determination of the tractive effort is made from a record of a pull on the draw bar, indicated by a tracing made on a strip of paper which moves under the point of a pencil, the latter being moved at right angles to the direction of motion of the paper by apparatus connected with dynamometer springs that measure the pull. The total work is automatically indicated by an apparatus provided for that purpose which saves the labor of computation. The speed of the train is automatically recorded by a tracing made on a revolving flat disk of paper, the motion of which, by ingenious mechanism, is made to harmonize with the speed of the train, the ratio between these being a constant. "The time is registered by means of a clock with electrical contacts by means of which a current is sent every ten seconds into a magnet that actuates a pencil." This therefore makes six marks per minute upon the paper band. The mechanism for tracing the datum lines, and effecting the movement of the paper band is ingenious.

"The analysis of the products of combustion is effected by two sets of Orsat apparatus placed below the observation seats. The analysis consists of measuring the percentage of carbonic acid, oxide, and oxygen. The residue is supposed to consist solely of nitrogen. A copper tube is suspended from the top of the locomotive chimney, and is connected by an india-rubber tube to a fixed flask into which the gas is drawn by an aspirator. The volume of gas to be analyzed is passed into a graduated tube, and then passed into test tubes containing absorbents. The first tube contains a solution of caustic potash, which absorbs the carbonic acid; the second contains a solution of potassium pyrogallate which absorbs the oxygen, and the third tube, a solution of cuprous chloride which absorbs the carbonic oxide. After each absorption the gas remaining is measured in the graduated tube, and the volume absorbed is the difference between the first and last measurements. The final residue is considered as nitrogen."

This car was first exhibited at the Paris Exhibition in 1889, and attracted much attention there. Since that time two others have been built. Renewed interest in the subject of locomotive testing has been excited by the application of this apparatus to a test of the Heilmann electric locomotive for the determination of its tractive power and speed, which machine is further mentioned in department of Electricity.

Locomotive Building in Russia.

RUSSIA as compared with other powerful nations presents the anomaly of a government quick to seize upon any modern improvement calculated to augment her military power, yet slow in the encouragement of arts which lead only to the social elevation of the masses of the population. Thus behind other nations in agriculture, and, generally speaking, in mechanic arts, she was one of the first continental nations in which railways were introduced. The first railway line constructed in Russia was from St. Petersburg to Zarskoje-Selo, opened for traffic in 1838. At that time railroading both in England and in America was in its infancy, so that Russia was not much behind in recognition of the practical advantages which have resulted from railway communication. Since that time, while in other countries the extension of railway traffic has been with a view to extension of commerce, in Russia military considerations have been of equal or greater influence in determining where and when railroads should be built.

Following up the history of Locomotive Building in Russia *The Railway Press* (London) finds its beginnings in 1844, when the government undertook the construction of the Nikolaī railway. It then leased the Alexandrow Works to an American company for the manufacture of the rolling stock of that road. But it is alleged that this company did not really manufacture locomotives or, at least, did very little manufacturing in the Alexandrow works except the erection of parts manufactured abroad and imported.

Towards the seventies the government once more attempted to establish the manufacture of locomotives as a home industry. "In 1866, an imperial ordinance was issued that in future all state contracts should be executed in Russia, whatever difficulties this might entail in the first years."

"Loans were consented to by the government for the construction of new works, or the enlargement of those already extant. Premiums were to be paid for promoting manufacture. The right of private railways to order from abroad was restricted, and import duties raised. At first the government did not think it wise to support more than three locomotive manufacturers, and promised to order from each of them fifty locomotives, to be delivered in the course of five years. The price of each passenger engine per ton was to be 775 roubles, and 750 roubles for goods engines. The weight according to which the price was reckoned was that of the empty engine. A sum of 300,000 roubles would be lent to manufacturers on mortgage. Finally, those who could obtain orders from private railway companies would receive premiums.

"Two large works, Malzew, in Brjansk, and the Newski, availed themselves of these offers. The Putilow and Baltic, in St. Petersburg, did not, however, enter into any arrangement with the government. Later on the Kama Wortinski received an order for eight locomotives, in accordance with the above conditions. At the same time the well-known Kolomna Works began to construct locomotives.

"The following table gives an idea of the progress of locomotive building in Russia:

Year.	Number of engines built in Russia.	Built abroad.
1867	217	790
1876	794	2470
1883	1490	790
1891	1105	....
Total at end of 1891,	3606	4050

"Thus at the end of 1891, out of a total of 7656 engines, 4050 or 53 per cent. were built abroad."

During the most active period in Russian railway building she could only supply 27 per cent. of the locomotives required. Since 1876 half of the locomotives required have been of home construction which is, at least partly, attributed to increase of import duty. A table of duties from 1876 to 1891 inclusive, is given. Prior to 1876 the duty was 1 rouble per poud. (A rouble is equal to $0.748 dollar U. S. and a poud is 36 pounds avoirdupois.)

The duty was increased in 1876 to 1¼ roubles per poud. From 1877 to 1881, it was 1¼ per poud on locomotive alone and $\frac{4}{8}$ rouble per poud on tender alone. In 1881 the duty was further increased to 1.375 roubles per poud on locomotive alone. From 1881 to 1887, it was 1.4 roubles per poud on locomotives alone, and 0.9 rouble on tender alone. From 1887 to 1891, the duty was 2 roubles per poud on locomotive alone, and 1 rouble per poud on tender alone. Since 1891 the duty has remained 2 roubles on locomotive alone but has been increased to 1.7 rouble on tender alone. On a locomotive weighing, say, 40 tons the duty would now be 4444.44 roubles which would at first sight seem to be prohibitive provided the cost of building a locomotive in Russia does not very much exceed that of other countries. It has not, however, proved wholly so, as locomotives are still imported to some extent. Activity now prevails in all Russian locomotive works, being stimulated by the construction of the great Trans-Siberian railway, which with necessary renewals, is likely to keep up this activity for a considerable period.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24306. La Guaira and Caracas Railway. E. H. A. Heinke (R P L–Aug.) 1500 w.

*25793. Locomotive Building in Russia: Its History and Development. Mernok (R P L–Oct.) 1400 w.

*25794. The Origin of the Railway System (R P L–Oct.) 2000 w.

*25826. Midland and Great Northern Joint Railways New Passenger Engines. Ill. Clement E. Stretton (R W–Oct.) 400 w.

*25827. An English Light Railway. Ill. (R W–Oct.) 1400 w.

*25829. The Theory of Railway Engine Motion. Clement E. Stretton (R W–Oct.) 1100 w.

25830. Friction and Brakes. Editorial (R C J–Oct.) 1800 w.

25832. Electricity—Its Application in Car Construction, Lighting Cars and Shops. Duane Doty (R C J–Oct.) 3600 w.

25833. Collar and Collarless Car Axles (R C J–Oct.) 2500 w.

25850. Rocky Mountain Work on the Great Northern. Ill. J. H. Kennedy (R G–Oct. 12.) 5300 w.

25859. Erection of Boston and Maine Train-Shed Roof. Ill. (E R–Oct. 13.) 1600 w.

25902. Responsibility for Joint Tariffs. Editorial (R R–Oct. 13.) 1800 w.

*25915. Indian Railway Development. Editorial (E–Oct. 5.) 2700 w.

*25919. Early Tramroads and Railways in Leicestershire. Clement E. Stretton (E–Oct. 5.) 1200 w.

*25935. The Working of the Railways. Editorial (Eng L–Oct. 5.) 2000 w.

*25936. A Dynamometric Railway Car. Ill. (Eng L–Oct. 5.) 2500 w.

26009. Handling Freight Trains with Air Brakes. F. M. Neilis (R G–Oct. 19.) 1500 w.

26010. An English Achievement in Excursion Traffic (R G–Oct. 19.) 1400 w.

26012. Enlargement of the North Eastern Railway Station at Newcastle, England. Ill. C. H. G. (R G–Oct. 19.) 800 w.

26014. The Industry of Train Robbing. Editorial (R G–Oct. 19.) 900 w.

26015. Pensions and Relief Funds for Railroad Men. Editorial (R G–Oct. 19.) 2800 w.

26023 Railroad Locomotive Boiler Inspection on the Central Railroad Company of New Jersey. Ill. (S V–Oct. 15.) 800 w.

26101. Report of Committee on Railway Signalling (R A–Oct. 19.) 1000 w.

26106. Car Sanitation. G. P. Conn (R R–Oct. 20.) 3000 w.

26108. Minor Railroad Economies. Editorial (R R–Oct. 20.) 800 w.

26109. Master Mechanics Association Standard Boiler Steel Specification (R R–Oct. 20.) 1700 w.

*26158. English Railroad Methods. Ill. H. G. Prout (Sc M–Nov.) 7000 w.

26184. Long Valve Travel and the Locomotive. "J. W. Miller." Letters and Editorial (R G–Oct. 26.) 2700 w.

26186. Lehigh Valley Coal Storage Plant at West Superior. Ill. (R G–Oct. 26.) 700 w.

26187. Passenger Rates in England and America. W. M. Acworth (R G–Oct. 26.) 1500 w.

26188. Coupler Tests at Chicago. Editorial (R G–Oct. 26.) 1700 w.

26193. The Air-Brake Patent Litigation and Its Lessons. Editorial (E N–Oct. 25.) 2200 w.

26194. The Air-Brake Patent Decision (E N–Oct. 25.) 1800 w.

*26208. Rack Railway in Japan. Ill. S. Kikkawa (E–Oct. 19.) 1700 w.

*26222. Great Northern Railway.—Works in Connection with the Widening of the Line at King's Cross. Ill. (Eng L–Oct. 19.) 1000 w.

*26223. The Inspection of Railway Bridges in India. Editorial (Eng L–Oct. 19.) 2000 w.

*26224. Railroading in America. Ill. By an English Railway Engineer (Eng L–Oct. 19.) 2800 w.

*26307. The Amendments to the New Zealand Railway Act (Tr–Oct. 19.) 600 w.

26310. Some Inconsistencies in the Signaling of Diverging Routes. C. C. Anthony (R R–Oct. 27.) 1200 w.

26311. Notes on Steel Sleepers. W. H. Cole (R R–Oct. 27.) 1200 w.

26312. The Air Brake Decision. Editorial (R R–Oct. 27.) 2200 w.

26313. Coupler Tests at the Works of the Chicago Tire and Spring Company (R R–Oct. 27.) 1200 w.

26314. Compound vs. Simple Engines. T. A. Fouque (R R–Oct. 27.) 1500 w.

*26360. Locomotive Injectors. George H. Baker (N C B–Nov.) 3000 w.

*26361. Piston Travel on Cars. F. B. Farmer (N C B–Nov.) 1800 w.

26401. New York City Rapid Transit. Ill. J. J. R. Croes (R G–Nov. 2.) 3200 w.

26402. The Puzzles of Rate-Making. Editorial (R G–Nov. 2.) 1800 w.

26403. Variation in Temperature in Locomotive Cylinders. Editorial. Ill. (R G–Nov. 2.) 3800 w.

*26404. A Trip to North Wales. Ill. A. S. (L E–Nov.) 2500 w.

*26405. Human Flesh and Blood as Steel Tempering Material (L E–Nov.) 800 w.

*26406. Frictional Resistance and Brake Efficiency. Editorial (L E–Nov.) 1500 w.

*26407. Inferior Boiler Tubes. Editorial (L E–Nov.) 1000 w.

*26408. Bunching Trains When Only Partly Equipped with Air. Will W. Wood (L E–Nov.) 1600 w.

26422.—$1. Reasonable Railway Rates. H. T. Newcomb (An A A–Nov.) 6000 w.

*26439. The Permanent Way of the Pennsylvania Railroad. Ill. (E–Oct. 26.) 2200 w.

*26442. The Railway Situation. Editorial (E–Oct. 26.) 1200 w.

26509. Owners of Cars Responsible for Defects. (Extract) J. N. Barr, with Editorial (R E M–Nov.) 2000 w.

26511. The Value of Compressed Air in and about Railroad Shops. Ill. F. M. Twombly (R E M–Nov.) 1100 w.

*26516. Locomotives and Trains. Editorial (Eng L–Oct. 26.) 1800 w.

*26545. The Hours of Labor of Railway Servants (Tr–Oct. 26.) 1500 w.

*26546. Railway and Waterway Competition on the Continent (Tr–Oct. 26.) 1200 w.

26548. Railway Rates in the Northwest. J. W. Kendrick (R A–Nov. 2.) 1800 w.

26549. The M. C. B. Coupler in 1894. Ill. A. M. Wait (R A–Nov. 2.) 3700 w.

26550. Railway Work in Argentine. Ill. Benjamin James Forrest (R R–Nov. 3.) 600 w.

26552. The Law on Routing Freight. Editorial (R R–Nov. 3.) 900 w.

26553. Intelligent Use of Material. Editorial (R R–Nov. 3.) 1400 w.

26620. West Virginia's Connections with the Lakes. Thomas Bruce (M R–Nov. 9.) 2000 w.

26633. Guard Rails; Elevated Railroads. Ill. (R G–Nov. 9.) 400 w.

26635. A Minimum Gage Railroad. F. B. L. (R G–Nov. 9.) 1200 w.

26636. The Heilmann Locomotive. Editorial (R G–Nov. 9.) 3000 w.

*26642. Railway Servants' Hours of Labor. Report of the Board of Trade (R'y T–Oct. 27.) 800 w.

*26643. The Grand Trunk Railway Company of Canada and Its Saviours. Editorial (R'y T–Oct. 27.) 900 w.

*26644. The Colar Gold Field and the Treatment of Its Tailings. A Correspondent on the Field (Min W–Oct. 13.) 1800 w.

26653.—$1 50. On Form of Railway Excavations and Embankments. Ill. D. J. Whittemore, with Discussion (T C E–Sept.) 4800 w.

Serials.

15496. Railroad Coppersmithing. Ill. John Fuller, Sr. (L E–Began Sept. 1893—Ended Nov. 1894—12 parts—30 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M–Began Jan.—8 parts to date—15 cts. each).

22639. A Master Car Builder's Reminiscences. John Kirby (R C J–Began June—3 parts to date—15 cts. each).

22869. The Enlargement of Liverpool Street Station, Great Eastern Railway. Ill. (Eng L–Began June 8—5 parts to date—30 cts. each).

23719. The Early Railway Routes to Scotland. G. A. Sekon (R P L–Began July—4 parts to date—30 cts. each).

24266. Brakes and Brake Calculations (R C J–Began Aug.—2 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R–Began Aug. 25—10 parts to date—15 cts. each).

24809. Car Shop Economy. James F. Hobart (N C B–Began Sept.—3 parts to date—30 cts. each).

24938. Passenger Train Service in 1894 (Tr–Began Aug. 31—3 parts to date—30 cts. each).

25663. The Mushkaf Bolan State Railway (I E–Began Sept. 1—2 parts to date—45 cts. each).

25670. Special Shop Tools. Ill. (R E M–Began Oct.—2 parts to date—15 cts. each).

25674. The New Central Railway Station at Lisbon. Ill. (E–Began Sept. 28.—Ended Oct. 5—2 parts—30 cts. each).

25795. What Our Railways Might Have Been. G. A. Sekon (R P L–Began Oct.—1 part to date—30 cts).

26400. Railroad Legislation and National Prosperity. Don Alexander (R G–Began Nov. 2—2 parts to date—15 cts. each).

26525. The Liverpool Overhead Railway (E R L–Began Oct. 26—1 part to date—30 cts).

26554. The General Theory of Rates. Charles H. Cooley (R R–Began Nov. 3—1 part to date—15 cts).

STREET RAILWAYS

City Ownership of Street Railways.

UPON the municipal ownership of street railways, a subject which is just now being discussed quite generally, *Engineering News* expresses the view that what it styles "honest public opinion" is decidedly in favor of municipal ownership instead of indefinite private control of public streets. The point is also urged, that provision for ultimate municipal ownership should be made in the letting of all street franchises. The experiments in municipal ownership in Detroit, Mich., and in Toronto, Canada, are mentioned, and some particulars are given.

"The Toronto plan has succeeded in spite of the loud declaration of more or less interested parties that no corporation would even bid for a franchise so hedged in with conditions; and it now remains for other American cities to follow the example laid down. As a rule, street railways are very profitable enterprises, there is no reason at all why the city should not share in the profits after the traveling public is granted what it should have—the best service at the lowest cost.

"In Toronto the 30-year lease of the street railways expired in 1891, and the municipality exercised its privilege of purchase. The award was made by arbitrators in this case, and the sum paid was about $1,500,000. Instead of attempting to operate the lines itself the city concluded to again sell the franchise for a fixed period of time, upon terms more favorable to the people and to the public treasury. The terms of sale required the purchaser to compensate the retiring street railway owners to the amount of the purchase by the city; to pay rental per mile of $800 per annum for single track and $1600 per annum for double track, and to pay a percentage upon gross receipts from all sources, as follows: Up to $1,000,000 per annum, 8 per cent.; between $1,000,000 and $2,000,000, 15 per cent.; upon all gross receipts over $3,000,000 per annum, 20 per cent. The purchaser was further required to replace horse traction by electric power, and to build additional lines where and when the city council might direct under the supervision of the city engineer. The city expressly reserved the right to regulate the speed and service necessary and to determine that while the single cash fare should be 5 cents, tickets should be sold in packages at 25 for $1, or 6 for 25 cents. Workingmen's tickets, to be used at stipulated morning and evening hours, were to be sold 8 for 25 cents, and tickets for school children, good between 8 A. M. and 5 P. M., were to be sold at the low rate of 10 for 25 cents. Severe as were these terms, so unusual in the experience of modern street railway magnates, the franchise was sold in September, 1891, and the system is now in complete working order, with the city as the party chiefly benefited, both in the form of a cash return and the greater cheapness and convenience of traffic to its citizens.

"This charter, as we understand it, terminates after a period of years and the city has the right to again purchase by arbitration the exact value of all that is necessary for the operation of the system then existing.

"Meanwhile the city engineer with the approval of the council, has the authority to prescribe the character of the rails and materials used by the company and in all matters pertaining in paving and the use of the streets the city retains full control. The contract conditions are altogether favorable to the public while permitting a just return to the operators of the system."

The T-Rail Question.

AS between T-rails, tram or centerbearing head rails, and grooved girder rails, for use in street railways, there has been an active discussion of late, and the whole subject having been referred to a committee of the American Street Railway Association, it made its report to that body at the convention held at Atlanta in October. It may be remarked here, that this convention appears to have been a success, so far as most of the objects sought by it are concerned, but the time appears to have been too short for the full discussion of some subjects of interest and importance to the street railway industry.

The formulated question referred to the committee was, "Can the T-rail be satisfactorily used on paved streets?" In presenting its report the commitee states that the word "satisfactorily" has been considered "as applying to the point of view of the city and the driving public," as well as that of street railway companies, and the endeavor is made "to show that the T-rail is not only satisfactorily used in streets, but that it is the best rail for the purpose." The report, prepared by Mr. Strathearn Hendrie, was printed in full in the *Street Railway Gazette* (Nov. 3), and probably no subject brought before the convention has a more important bearing upon the future of street railway traffic than this.

"The tendency of the larger cities in this country during the past 10 or 12 years has been toward smoother and better paved streets; and the general public, watching the progress of its city officials, has become in many places impatient of the action of the street railway people in maintaining the old forms of rail, which makes a ridge on the smooth surface of a first class modern street in an American city. Our travelers have come home from England and the continent extolling the grooved rail, and our city officials have in many cases forced either the English grooved rail or its American modification upon the railway companies. No street railway man hankers after the grooved head before he gets it, or enjoys it after he has put it in, and he therefore fights its introduction, demanding to be left alone, as he was, with his center-bearing or five-inch tram head. What we would show him—and through and beyond him his public—is that he can progress in the direction of their desires for a smooth street, and can give them something even more satisfactory to them than their favorite grooved rail."

On the other hand "questions of price, quick delivery, competition, coal-pile and construction, combine to recommend the T-rail" to street railway men. The tram-head has been proved not to be the cheapest rail in the end in these days of good street pavements and rapid transit. "Wagon traffic goes where it belongs—on the side of the street." The day of the old center bearing rail is regarded as past for most street railways and the choice now lies between the T-rail and the grooved headed rail.

"While the suggestion of a T-rail, for use in paved streets in cities, is startling to the average citizen, alderman or city engineer, and is in most cases impatiently rejected by them, yet we must recollect that the mention of a rail, such as steam roads use, calls up in their minds the idea of four or five inches of steel standing up above the street and of dilapidated plank crossings with half-drawn spikes, and we should go patiently to work to teach them that, as there is more than one way to supply motive power to a car, so there is more than one way of putting a rail in the street."

As an aid to the proper consideration of the subject in all its bearings, from the point of view which street railway men are compelled to take, as well as that of the public, the report contains a tabulated statement relating to 26 different railways where the T-rail is used. The general subject of street paving is considered. Over 50 different roads using T-rails and belonging to the association, either neglected or declined to respond to the inquiries of the committee, a fact which does not indicate that regard for mutual interest that ought to exist in such a body.

"The general consensus of opinion of the 26 roads referred to, and of the officials of the cities in which they run, is that if you can once get down 100 yards of T-rail and make a decent job of the paving, neither the officials nor the citizens will permit you to use anything else in the future. The main thing is to make your paving job a neat and good one. In three of the other cities, where there are at present no T-rails, but which are blessed with enlightened city officials, the T-rail is about to be made a requirement on the companies."

In the tabulated statement the replies are directed to the following points: Location; name of company; miles of rail of each variety in use, their weight and heights; construction; character of pavements and filling, and general remarks upon the estimation in which T-rails are held by both city and railway officials and the general public. Under these heads much valuable information has been collected.

Perfection of the Electric Railway Motor.

A STUDY of the history of the electric railway motor, says Lincoln Nissley in a paper recently read before the Pennsylvania Street Railway Association, and printed in the *Street Railway Journal* (October), shows that for the first few years after its introduction there was a strong tendency in the direction of complicated, fanciful and impracticable designs, outlandish forms of field magnets and unnecessary numbers of field cores and coils. The mechanical construction, too, has often been bad, the shaft being too small, the bearings weakly supported and the general workmanship inferior. Commutators and brushes have heretofore been the weakest spot in the railway motor, but the troubles with these have already been to a great extent overcome by the leading manufacturers. But serious difficulties still remain in connection with proper control and regulation. The government of motors as now effected by variable resistances in the circuit, necessarily involves great waste of power. This is unfortunate, but is it necessary? Mr. Nissley thinks not. The current, he suggests, should be adjusted by the motor itself, and not by the action of the motorman. The speed of the motor should remain absolutely constant, while for regulation between the motor and driving-wheels, the mechanical advantage should be made variable. The single-reduction motors of recent manufacture are a great advance in the onward march towards perfection. In the future will come better engineering, better construction, better mechanics, and the solution of the larger problems which will place the perfected railway motor on a better, cheaper and more successful basis.

Application of the "Booster" in Electric Railway Service.

DEVICES for raising the potential in certain branches of a system of electrical distribution without affecting that of other circuits supplied from the same source, have been in use for some years in connection with central station dynamos, and have come to be known by the expressive, if not elegant, title of "boosters." A paper read before the street-railway convention at Atlanta by J. H. Vail and H. S. Wynkoop, printed in the *Street Railway Gazette* (October 30), points out in a forcible manner some of the advantages which will accrue from the application of this device to the feeders of street-railway circuits. At present, the cost of copper for conductors seriously restricts the profitable extension of long distance lines for the accommodation of suburban traffic. For a given service, the cost of copper increases directly as the square of the distance from the generator, and this fact often renders the necessary investment in copper prohibitory when the line is to extend more than three or four miles from the power house. The authors state that accurate tests show that the commercial efficiency of the street-railway motor may be as high as 78 per cent. at normal voltage, but falls as low as 52 per cent. at two-thirds the normal. As a consequence, the cars when at a distance from the station, not only run at a much slower speed, but at an increased cost for power. The principle of the booster is that of overcoming the loss of voltage in transmission through long feeders by automatically raising the initial voltage of each feeder by an amount which shall exactly compensate for the drop of potential on the feeder at any given instant. The cross section of the feeder may therefore be calculated for ampere capacity only, the pressure being maintained at the service end of the line equal to that at the station end, irrespective of the length of the feeder or the amount of load. Several graphic diagrams are given which present the advantages of the proposed system in a very forcible manner. The most important general fact is, that the cost of copper when the device is used, increases only in direct ratio to the distance from the central station, instead of increasing as the square of the distance as under present conditions. This circumstance enables the street-car service to be extended to a distance of 10 to 20 miles from the power house, at the same time retaining the investment in copper within reasonable limits. One great advantage of the booster is that it may be kept in the station and thrown at a moment's notice on any circuit which may be burdened with an abnormal load, thus greatly increasing the flexibility of the railway system as a whole. It would seem as if this simple device ought to save a great many tons of copper in such cities as Boston, Brooklyn and Philadelphia.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25763. The Street Railway Systems of St. Louis—Object Lessons in Efficient Service. Ill. William H. Bryan (E Mag-Dec.) 3500 w.

25848. Rapid Transit in New York (R G–Oct. 12.) 2400 w.

25956. Street Railway Repairs. J. B. Cahoon (E W–Oct. 20.) 5000 w.

†25971. Continued Discussion of Elmer A. Sperry's Paper—"The Electric Brake in Practice" (T A I E E–Oct.) 4000 w.

25987. A Few Figures on Electric Railway Expenses of Operation (E E N Y-Oct. 17.) 800 w.

25998. Rapid Transit Railways in European Cities. Ill. William Barclay Parsons (E N–Oct. 18.) 7500 w.

25999. An American Street Car of 1855. Ill. (E N–Oct. 18.) 800 w.

26000. Power-Brakes vs. Hand-Brakes for Street Cars. (Abstract.) E. J. Wessels (E N–Oct. 18.) 1500 w.

26002. Proposed New Rapid Transit Line in Chicago (E N–Oct. 18.) 1000 w.

26004 Progress in Gas Motors for Street Railways (Abstract.) Frank H. Mason (E N–Oct. 18.) 1000 w.

26005. Power Brakes for Street Railway Cars. Editorial (E N–Oct. 18.) 2100 w.

26006. A German Rail-Cleaning Machine for Street Railway Tracks. Ill. R. Ziffer (E N–Oct. 18.) 700 w.

26007. Mail, Express and Freight Service on Street Railways. (Abstract.) Richard McCullock (E N–Oct. 18.) 2500 w.

26008. Brakeshoes for Street Railway Cars. (Abstract.) D. F. Henry (E N–Oct. 18.) 2000 w.

26011. City and Suburban Electric Railroads. (Extracts.) E. C. Foster (R G–Oct. 19.) 1800 w.

56013. Some Problems in the Construction and Operation of Elevated Railroads. A. A. Stuart (R G-Oct. 19.) 2700 w.

26016. Some Unsolved Problems of Elevated Railroads in Chicago. Editorial (R G–Oct. 19) 3500 w.

26018. The Electrical Expansion of the Chicago City Railway Company. Ill. Clement C. Smith (W E–Oct. 20.) 1600 w.

26019. Electricity in Elevated Railroads. B. J. Arnold (W E-Oct. 20.) 1600 w.

*26035. The Corrosion of Iron Pipes by the Action of Electric Railway Currents. Dugald C. Jackson, with Discussion (J A E S–Sept.) 9000 w.

26054. The Use of the Booster on Electric Railway Circuits. J. H. Vail and H. S. Wynkoop (S R G–Oct. 20.) 2000 w.

26055. Destructive Arcing of 500-Volt Fuses. W. S. Harrington (S R G–Oct. 20.) 1100 w.

26163. The T-Rail Track Construction of the Terre Haute Electric Railway. Russell B. Harrison (E W–Oct. 27.) 1700 w.

26185. The Elevated Railroads of Chicago. Ill. (R G–Oct. 26.) 4400 w.

†26269. Report of the Committee on "A Standard Form of Street Railway Accounts." H. I. Bettis (S R J–Nov.) 6000 w.

†26270. Report of the Committee on "Transfers on Street Railways." J. N. Beckley (S R J–Nov.) 2000 w.

†26271. Report of the Committee on "Can the T-Rail Be Satisfactorily Used on Paved Streets?" Strathearn Hendrie (S R J–Nov.) 1600 w.

†26272. Special Paper on "Brake Shoes." Powell Evans, with Discussion (S R J-Nov.) 8000 w.

†26273. The Poughkeepsie and Wappingers Falls Electric Railway. Ill. J. H. Vail (S R J–Nov.) 1500 w.

*26274. The Overhead Construction of the New Orleans Traction Company. Ill. B. Willard (S R R–Oct.) 800 w.

*26275. The Tamo and Toledo Electric Railway.—Two Small Iowa Towns United with a Paying Electric Road. Ill. (S R R–Oct.) 1200 w.

*26295. On Multiple Series Control of Motors on Small Electric Railways. John Langton (S R E N–Oct.) 1000 w.

26450. Uniformity in Stopping Cars in Philadelphia (S R G–Nov. 3.) 700 w.

26469. Rapid Transit for New York City and Municipal Ownership of Street Railways. Editorial (E R–Nov. 3.) 1200 w.

26599. Hewett's Conduit Railway Trolley. Ill. (W E–Nov. 10.) 1300 w.

26627. The New York Terminal Station of the Brooklyn Bridge. Ill. (E N–Nov. 8.) 4000 w.

Serials.

25022. The Working Expenses of Electric and Cable Railways (R W–Began Sept.—2 parts to date—30 cts. each).

25348. Mechanical Traction for Tramways (E E L–Began Sept. 14—3 parts to date—30 cts. each).

25954. Electric System of the Philadelphia Traction Company. Ill. Hermann S. Hering (E W–Began Oct. 20—Ended Nov. 10—4 parts —15 cts. each).

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

Unsolved Problems of Science.

THE inaugural addresses of the presidents of the British Association for the advancement of Science and Art, have as a rule commanded the attention of the scientific world. Few of them, however, have been of a character to interest such as have not had special scientific training. The inaugural address of the Marquis of Salisbury, Chancellor of the University of Oxford, who has this year been elected to the presidency of the association, while in nowise lowering the literary standard of these addresses, deals with subjects of a kind comprehensible to educated people generally. As an address delivered by an eminent man before an old and honorable association upon a class of topics of profound interest to all thinking men, whether professional scientists or not, it is regarded as one of the most remarkable of recent public utterances. The *Popular Science Monthly* editorially speaks of it as an "allocution not to the British Association . . . . but to the British public." The problems named as unsolved, and yet which seem by their extreme interest and importance to challenge continued effort, notwithstanding all previous attempts have failed, indicate the purpose of the address almost as much as the way in which they were considered.

"In the presence of the high priests of science, I am only a layman, and all the skill of all the chemists the association contains cannot transmute a layman into any more precious kind of metal. Yet it is my hard destiny to have to address on scientific matters probably the most competent scientific audience in the world."

This from the opening paragraph of the address exemplifies the difficulty of adjusting the discourse to a level acceptable both to scientists of a high order and to educated men who in comparison are but laymen. Another sentence further illustrates the difficulty of the situation. "If a country gentleman, who was also a colonel of volunteers, were by any mental aberration on the part of the commander-in-chief to be appointed to review an army corps at Aldershot, all military men would doubtless feel a deep compassion for his inevitable fate. I bespeak some spark of that divine emotion when I am attempting to discharge under similar conditions a scarcely less hopeless task."

"Science with the university for many generations bore a signification different from that which belongs to it in this assembly. It represented the knowledge which alone in the middle ages was thought worthy of the name of science. It was the knowledge gained not by external observation, but by mere reflection. The student's microscope was turned inward upon the recesses of his own brain; and when the supply of facts and realities failed, as it very speedily did, the scientific imagination was not wanting to furnish to successive generations an interminable series of conflicting speculations. That science—science in our academical sense——had its day of rapid growth, of boundless aspiration, of enthusiastic votaries. It fascinated the rising intellect of the time, and it is said—people were not particular about figures in those days—that its attractions were at one time potent enough to gather round the university thirty thousand students, who for the sake of learning its teaching were willing to endure a life of the severest hardship. Such a state of feeling is now an archæological curiosity. The revolt against Aristotle is now some three centuries old. But the mental sciences which were supposed to rest upon his writings have retained some of their ascendency even till this day, and have only slowly and jealously admitted the rivalry of the growing sciences of observation.

"Few men are now influenced by the strange idea that questions of religious belief depend on the issues of physical research. Few men, whatever their creed, would now seek their geology in their books of their religion, or on the other hand, would fancy that the laboratory or the microscope could help them to penetrate the mysteries which hang over the nature and the destiny of the soul of man."

Three of the yet unsolved problems of science form the subject of the address; to wit, the nature and origin of what are called chemical elements; the ether which is described as "a half-discovered entity," and animal and vegetable life styled "the action of an unknown force upon ordinary matter." The mystery of the material elements, is regarded most notable, on account of the disappointed hopes that have been reared upon discoveries of new means of research made from time to time. Among these was the method of spectrum analysis.

"Men thought that with an instrument of such inconceivable delicacy we should at last find out something as to the nature of the atom. The result has been wholly disappointing. Spectrum analysis in the hands of Dr. Huggins and Mr. Lockyer and others has taught us things of which the world little expected to be told. We have been enabled to measure the speed with which clouds of blazing hydrogen course across the surface of the sun; we have learned the pace—the fabulous pace—at which the most familiar stars have been for ages approaching to or receding from our planet, without apparently affecting the proportions of the patterns which, as far as historical record goes back, they have always delineated on the evening sky. We have received some information about the elementary atoms themselves. We have learned that each sort of atom, when heated, strikes upon the ether a vibration, or set of vibrations, whose rate is all its own; and that no one atom or combination of atoms, in producing its own spectrum, encroaches even to the extent of a single line upon the spectrum that is peculiar to its neighbor. We have learned that the elements which exist in the stars, and especially in the sun, are mainly those with which we are familiar upon earth. There are a few lines in excess to which we can give no terrestrial name, and some still more puzzling gaps in our list. It is a great aggravation of the mystery which besets the question of the elements that, among the lines which are absent from the spectrum of the sun, those of nitrogen and oxygen stand first. Oxygen constitutes the largest portion of the solid and liquid substance of our planet, so far as we know it; and nitrogen is very far the predominant constituent of our atmosphere. If the earth is a detached bit whirled off the mass of the sun, as cosmogonists love to tell us, how comes it that in leaving the sun we cleaned him out so completely of his nitrogen and oxygen that not a trace of these gases remain behind to be discovered even by the sensitive vision of the spectroscope?

"All these things the discovery of the spectrum anslysis has added to our knowledge; but it has left us ignorant as ever as to the nature of the capricious differences which separate the atoms from each other, or the cause to which those differences are due."

Dalton's, Kirchoff's, and Mendeleef's researches have not, so far as can now be seen, helped toward a solution. "What the atom of each element is, whether it is a movement, or a thing, or a vortex, or a point having inertia, whether there is any limit to its divisibility, and, if so, how that limit is imposed, whether the long list of elements, is final, or whether any of them have any common origin, all these questions remain surrounded by a darkness as profound as ever. The dream which lured the alchemists to their tedious labors, and which may be said to have called chemistry into being, has assuredly not been realized, but it has not yet been refuted."

Of ether it is asserted that "it would be a great exaggeration of our knowledge" to "speak of it as a body, or even a substance . . . When nearly a century ago, Young and Fresnel discovered that the motions of an incandescent particle were conveyed to our eyes by undulation, it followed that between our eyes and the particle there must be something to undulate.

In order to furnish that something, the motion of the ether was conceived, and for more than two generations the main, if not the only, function of the word ether has been to furnish a nominative case to the verb to undulate." Notwithstanding Professor Maxwell's discovery of the coincidence existing between "the figure that expresses the velocity of light" and "the multiplier required to change the measure of static or passive electricity into that of dynamic or active electricity," the "attractive experiments of Professor Hertz," etc., "the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before."

Life,—"the mysterious influence which is able to strike across the ordinary laws of matter and twist them for a moment from their path,"—what is it? "Biology has been exceptionally active and successful during the last half century. Its triumphs have been brilliant and they have been rich enough not only in immediate results but in the promise of future advance. Yet they give at present no hope of solving the great central mystery. The doctrine of evolution does not help. If however the doctrine of natural selection be rejected, we have no resource but to fall back on the mediate or immediate agency of the principle of design."

In concluding the address an expression of Lord Kelvin is quoted with approval:

"I have always felt that the hypothesis of natural selection does not contain the true theory of evolution, if evolution there has been in biology."

Instruction in Physics and Thermodynamics.

THE science of thermodynamics in which the late Professor Rankin was among the famous pioneers, is now scarcely fifty years old, yet it has taken rank in importance with the older sciences, and is taught in all technical schools worthy of the name. To it are due nearly all the refinements in steam engineering which have made the last half of the nineteenth century a distinct epoch in the history of the steam engine. Without it the caloric engines of Ericsson and others could scarcely have come into existence, and the gas engine (progress in which during the last twenty years has been one of the remarkable features of this period), if it had ever come into use at all, would have been only a crude, inefficient machine with limited application, scarcely worthy to rank as a motor for industrial purposes.

Such having been the practical results of this science, it is interesting to read what is said in *Nature* (October 4) about the facilities afforded for its study, and the course of instruction pursued in it at one of the great technical schools. Under the title "Physics and Engineering at the McGill University, Montreal," is given an illustrated description of the thermodynamic, geodetic, electrical and mathematical laboratories, at this celebrated institution of learning, with illustrations and descriptions, and also of its famous testing laboratory, and its well-equipped machine shop, which have contributed to make it a typical modern technical school.

"The McDonald Engineering Building, erected and equipped through the munificence of Mr. W. C. McDonald, one of the governors of the university, is a fine structure containing laboratories for all branches of engineering work. The Physics Building owes its existence to the generosity of the same donor. It has been designed for the teaching and study of physics (including mechanics) with special regard to (1) its intrinsic importance as an integral part of a liberal education in the Faculty of Arts; (2) its essential necessity as a study preliminary to the courses of engineering, mining, and practical chemistry in the Faculty of Applied Science, and (3) the prosecution of scientific research." The completeness and liberality with which all the necessary plant has been put into these buildings has hitherto never been equaled. "It will astonish the various authorities who have similar technical institutes under their control in this country (England) to know that the cost of this equipment alone of the two buildings came to very nearly one hundred thousand pounds sterling! Compare this princely generosity with the fact that only twenty-three thousand pounds were asked for to erect and equip the engineering laboratory of the University of Cambridge. The exact amount of Mr. McDonald's benefactions has not been told, but they are certainly nearer seven than six figures. Everything in fact required in the pursuit of physical and engineering study has been lavishly provided. Few occupiers of chairs of physics here are in the fortunate position of Professor Cox. He was instructed to spare no expense in obtaining everything required to carry on work in experimental physics. 'From first to last,' he says, 'whether it was a question of part of the buildings or of the equipment, I have heard no other language from Mr. McDonald than 'Let us have everything of the best, with a definite aim for everything, but always of the best.'"

The equipment of the thermodynamic laboratory and the course of study pursued in this science are notable. In this laboratory the feature of most interest is a four-cylinder steam engine arranged double tandem fashion designed by Messrs. Schonheyder and Druitt Halpin, London, under the general direction of Prof. Carus-Wilson of McGill College, and built by Yates and Thom, Blackburn. This engine is described as "a double tandem inverted direct acting quadruple expansion engine," to work at 200 pounds pressure on the gage, developing eighty horse-power at about 150 revolutions, and it may be used in a large number of different ways, for the elucidation of the thermodynamic principles involved in the theory and practice of steam engineering. "It may be run either quadruple, triple, double, or single expansion. And as the pipes are led both to condenser and atmosphere, all of these types may be tried either condensing or non-condensing." The power delivered is accurately measured by hydraulic brakes designed by the late R. E. Froude, and improved by Prof. Osborne Reynolds. "In fact, a complete balance sheet of the heat supplied, used, and rejected by the engines can be made, and the materials for the study of Hirn's analysis are easily obtained."

A special laboratory is provided for the third year course in thermodynamics. This contains apparatus for the experimental study of the so-called permanent gases, which as has been now amply demonstrated are such only under special conditions of temperature and pressure. In this laboratory are all the most approved instruments and appliances for measurement of temperature and pressure. The third and fourth year courses of study in thermodynamics are as follows:

The third year laboratory contains apparatus for the demonstration of the properties of the permanent gases and of steam: and a complete set of the most modern types of pyrometers and thermometers, and gages, mercury columns, planimeters, and calorimeters, render possible investigation of many problems of importance to the engineering world.

"In the third year, students of thermodynamics are taught the principles of the science by direct experiment; and original research is encouraged during the summer under the direction of the professor.

"In the fourth year, engine boiler and fuel testing is largely worked at; and the higher parts of the subject are explained by reference to the results obtained from the indicator card, as measured and examined for moisture and heat exchange. The gas and hot-air engines are tested again and again, and the effect of the different factors which modify results pointed out by careful observation."

Education of Engineers.

In an essay on Engineering Practice and Education in the *Journal of the Franklin Institute* by Prof. Gaetano Lanza, the importance of thorough school drill in scientific principles is emphasized, and the two fundamental sciences upon which principles involved in the practice of engineering rest are held to be mathematics and physics. While natural laws can only be discovered by experiment, the function of mathematics is to draw necessary conclusions from assumed data. If the data are not correct the necessary conclusions may be false, though no fault in mathematical reasoning may exist. It is the function of physics in the practice of the arts to supply needed fundamental data, and to correct false assumptions.

An engineer in order to be fit "to assume responsibility at some portion of his career, before he allows himself to use a formula in practice ought to know just how it is deduced. The rule-of-thumb engineer ignores this matter, and allows himself to risk the money, the safety and the lives of his fellow-men by making use of constants and mathematical formula found in some hand-book or elsewhere; using these constants and formulæ blindly, without knowing how they were deduced, or whether they have any reasonable foundation to stand on; or, in other cases, contents himself with merely guessing at what should be the dimensions of the various parts of a structure or machine. The natural result of such a course is poor work, and often disaster; and the world is rapidly waking up to this fact, so that important engineering work is being less and less entrusted to these rule-of-thumb engineers."

Neither drill on puzzling problems, nor long practice in "a certain round of operations" will qualify a man to use mathematical methods with skill in his profession, unless these modes of study are directed by a competent teacher.

The Rubber Traders of the Ucayali Valley.

AN illustrated article with a map of the Ucayali Valley in Peru, by José de la Sanchez in the *India Rubber World* (Oct. 15) gives a description of a region little known to the average citizen of the United States, yet one from which much of a material necessary to personal comfort and to the conduct of important industries (india rubber) is derived. The impression that much of the interior of Peru is difficultly accessible, usually gained from ordinary maps of Peru, is corrected. "Intrepid explorers have established the fact that the water-courses there, so carelessly depicted on the school-maps, form an extensive system of navigable streams discharging through the Amazon into the Atlantic ocean, and thence coming in touch with the great transportation systems of the world. The further fact having been established of the prevalence along these streams of rubber-bearing trees of the genus Hevea —the product of which is the most valuable freight in the world, barring the precious metals,—it has remained only for men of enterprise and capital to locate in this field and avail themselves of nature's great opportunities. The fact is that many individuals of this class are already engaged in rubber-gathering in Peru, and that marked success has attended the efforts of some, although their distance from any great trade center may have kept the world in ignorance of their existence."

Steamship lines exist whereby freights "may be billed from New York, or the great European seaports to Iquitos, far up on the Amazon, and exports from that far-away port are dispatched regularly for North America and the transatlantic markets." But when at Iquitos the head of navigation is by no means attained. A little further up is the great Ucayali river which contributes its waters to the vast tide of the Amazon, and this tributary, as well as steams flowing into it are navigable, the lands through which they flow producing valuable commodities among which rubber output is at present most notable, and likely to continue so for some time. The rubber product of these upper tributaries whose sources are in a region in the vicinity of Cuzco, does not, however, at present reach the markets of the world through the Amazon, but is conveyed to the Pacific by means of country roads and railroads, trains now being run as far toward Cuzco as Sicuani. Some "German merchants have extended their enterprise to the banks of the river Paucartambo, the waters of which, finally reach the Ucayali."

As yet Iquitos is the highest Amazonian point to which shipments can be made directly from New York, but the large and productive region "Amazonian Peru," must at some time be brought into closer connection with United States commerce. Flour and kerosene are the principal commodities now shipped from New York to eastern Peru. Ubiquitous England has the monopoly of the trade in finer manufactured goods.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24443. Presidential Address of the Marquis of Salisbury Before the British Association (E E L–Aug 10.) 6600 w.

*25761. The Armor Plate Question—1894. Ill. W. H. Jaques (E Mag–Dec.) 3500 w.

*25769. Restoration of the Antillean Continent. (Abstract.) J. W. Spencer (G M–Oct.) 1500 w.

*25770. On a Series of Saurian Footprints from the Cheshire Trias (with a Note on Cheirotherium). Osmund W. Jeffs (G M–Oct.) 2000 w.

*25771. The Aptychus. Ill. Ernest H. L. Schwarz (G M–Oct.) 1800 w.

*25787. The Ideal Preparatory School for Engineering Students. William Kent, in Cassier's Magazine (S L–Oct.) 1800 w.

25802. Cathodic Rays. Ill. C. E. Guillaume (Sc A S–Oct. 13.) 3000 w.

25803. New Researches on the Infra-Red Region of the Solar Spectrum. Professor Langley (Sc A S–Oct. 13.) 1200 w.

*25822. The Uses of Thermodynamics. Editorial (I & I–Sept. 28.) 900 w.

*25865. Uses of the Tailless Kite for Meteorological and Similar Purposes (Inv–Oct. 6.) 1300 w.

25867. Professor Dewar's Investigations (P A–Oct. 15.) 1600 w.

*25881. British Forestry (J S A–Oct. 5.) 2400 w.

25888.—$1. The American Cave-Dwellers: The Tarahumaris of the Sierra Madre. Carl Lumholtz (B G S–Sept. 30.) 8400 w.

25889.—$1. Fur Seals and the Behring Sea Arbitration. J. Stanley Brown (B G S–Sept. 30.) 13600 w.

25890. The Laboratory and Machinery.—Technical and Mechanical Matters of Value to Practical Man (T–Oct. 15.) 1600 w.

*25909. Physics and Engineering at the McGill University, Montreal. Ill. (N–Oct. 4.) 3000 w.

*25929. Dust Explosions in Briquette Works (C G–Oct. 5.) 1000 w.

*25934. Artillery Fire in the Chinese War. Editorial (Eng L–Oct. 5.) 1700 w.

25941. Sins of the Pay Roll. Fred Woodrow (A S–Oct. 13.) 800 w.

†25958. A History of Seamless Cotton Hose. Cornelius Callahan (I R W–Oct. 15.) 1500 w.

†25959. The Rubber Traders of the Ucayali Valley. Ill. José de la Sanchez (I R W–Oct. 15.) 1500 w.

†25960. The Rubber Product of British India (I R W–Oct. 15.) 1100 w.

†25961. Cholera and the Sultan. Ernest Hart (N C–Oct.) 7000 w.

*25975. The Influence of the Early Renaissance on Painting. Ill. Banister F. Fletcher A R–Oct.-Dec.) 7000 w.

25990. Specifications for a Proposed Catamaran Air Ship for United States Coast Defense. Ill. Invented by J. Franklin Cameron (Sc A S–Oct. 20.) 1400 w.

25993. The Paris Observatory.—The Oldest and Newest Telescopes. Ill. (Sc A S–Oct. 20.) 1000 w.

26020. How and Where Paranite Insulation is Made. Ill. (The Factory of the Indiana Rubber and Insulated Wire Company.) (W E–Oct. 20.) 2000 w.

26030. Egypt as a Cotton-Grower (M R–Oct. 19.) 2700 w.

†26038. Sanitary Delusions. F. L. Oswald (N S R–Oct.) 2200 w.

†26039. What is Science? Compiled by Mrs. H. O. Ward (N S R–Oct.) 5000 w.

†26040. The Influence of Heat and Cold upon Microbes. Lawrence Irwell (N S R–Oct.) 2800 w.

*26051. Engineering as a Learned Profession. Editorial (E–Oct. 12.) 3000 w.

*26092. Fifteen-Inch Pneumatic Dynamite Gun. Ill. (I & I–Oct. 12.) 3800 w.

*26134. Measurements of Precision. T. C. Mendenhall (N–Oct. 11.) 5000 w.

*26151. Modern Agriculture in France. H. Blerzy (Ch–Nov.) 4000 w.

*26152. The Value of Geological Science to Men. N. S. Shaler (Ch–Nov.) 3000 w.

†26153. The Glaciers of Greenland. Ill. Angelo Heilprin (P S M–Nov.) 4000 w.

*26212. The Field Columbian Museum. Editorial (E–Oct. 19.) 1600 w.

26261.—$1. Some Notes on Fire Protection Engineering. Ill. John R. Freeman (A E C U–1894.) 14500 w.

†26262. The Fight Off the Yalu River. Ill. Hilary A. Herbert (N A R–Nov.) 4400 w.

*26267. On Hollow Pyramidal Ice Crystals. Ill. (Abstract.) Karl Grossmann and Joseph Lomas (N–Oct. 18.) 1500 w.

*26284. The Model Foreman Engineer. Joseph Newton (I C B–Oct. 19.) 1500 w.

*26317. The Salt Trade of the Soudan (B T J–Oct.) 900 w.

*26319. New Brazilian Customs Regulations for Porto Alegre and Rio Grande do Sul (B T J–Oct.) 2500 w.

*26320. New United States Customs Tariff (B T J–Oct.) 6000 w.

*26321. Tariff Changes and Customs Regulations.—Russia, Sweden, Switzerland, France, Spain, Portugal, Porto Rico, Guatemala, China, Peru, British India, etc. (B T J–Oct.) 3500 w.

†26331. Tests of Automatic Fire Sprinkler Heads. Ill. D. S. Jacobus (S M–July.) 4500 w.

†26332. Comparison of Insulating Materials for Cold Storage. Rudolph Riege and Frank L. Parker (S In–July.) 2000 w.

26345. Unwelcome Discoveries.—From the Minneapolis Times (Sc A-Nov. 3.) 600 w.

26353. The Progress of Astronomical Photography. (Abstract.) H. C. Russell (Sc A S-Nov. 3.) 3500 w.

26354. About the "Freezing Up" of Compressed Air. Frank Richards (A M-Nov. 1.) 2400 w.

†26376. On Variations and Mutations. W. B. Scott (A J S-Nov.) 8000 w.

†26378. On the Origin of Bitumens.—A Retrospect. S. F. Peckham (A J S-Nov.) 2500 w.

†26380. A Study of the Cherts of Missouri. Edmund Otis Hovey (A J S-Nov.) 2500 w.

†26381. On Copper Crystals in Aventurine Glass. Henry S. Washington (A J S-Nov.) 2500 w.

26399. The Pneumatic Dynamite Gun on the Brazilian Cruiser "Nictheroy." Edward Brimley (E N-Nov. 1.) 1500 w.

*26434. Theoretical and Experimental Investigations on the Visual Sensations and on Photometry. Ill. André Broca (El-Oct. 26.) 2000 w.

*26443. Engineers of To-day—and Yesterday. G. H. Hill. Ill. (E Rev-Oct. 20.) 800 w.

*26446. The Engineering Industries of Manchester. Ill. (E Rev-Oct. 20.) 24500 w.

*26449. Modelling in Clay (I C B-Oct. 26.) 1500 w.

26457. The Photometry of Diffused Reflection. E. Lommel (A G L J-Nov. 5.) 1200 w.

26484. Heat. F. R. Law (Pr-Nov.) 10000 w.

26519. A New Classification of Economic Geological Deposits. R. W. Raymond (E M J-Nov. 3.) 2500 w.

26530. Antoine Louis Baryl and His Monument. Ill. (Ml N-Nov.) 1400 w.

26535. On the Velocity of Cathode Rays. J. J. Thomson (E N Y-Nov. 7.) 2700 w.

*26544. On Modern Developments of Harvey's Work. T. Lauder Brunton (N-Oct. 25.) 10200 w.

26578. Pompeii (A A-Nov. 10.) 2000 w.

26588. Church Bells. S. S. Stanley (A & B-Nov. 10.) 2000 w.

†26601. The Limit of Post-glacial Submergence in the Highlands East of Georgian Bay. F. B. Taylor (A G-Nov.) 6500 w.

†26602. A Review of the History of the Great Lakes. J. W. Spencer (A G-Nov.) 4200 w.

†26603. Drainage Systems of the Carboniferous Area of Michigan. E. H. Mudge (A G-Nov.) 2400 w.

†26604. The Mineralogical Characters of Certain New Jersey Limestones. Lewis G. Westgate (A G-Nov.) 1500 w.

†26605. The Ventral Armor of Dinichthys. Ill. Albert A. Wright (A G-Nov.) 1800 w.

26606. Herman Ludwig Ferdinand von Helmholtz. Ill. (Sc A-Nov. 10.) 1100 w.

26609. Engineering Facts. George Y. Wisner (Sc A S-Nov. 10.) 1800 w.

26611. Fuels in the United States (M S P-Nov. 3.) 600 w.

26628. Co-operation Among Engineering Societies. Editorial (E N-Nov. 8.) 1500 w.

†26637. Bolivia as a Source of Rubber Supply. William Nelson Black (I R W-Nov. 10.) 800 w.

†26638. The Cable Process for Treating Compounded Rubber (I R W-Nov. 10.) 900 w.

†26639. The Rubber Production of West Africa (I R W-Nov. 10.) 1800 w.

†26640. The Growing Use of Rubber for Tires (I R W-Nov. 10.) 800 w.

†26641. Glimpses of the Bolivian Rubber Country. M. F. Sesselberg (I R W-Nov. 10.) 1400 w.

*26647. The "Black Ivory" Trade (F'y-Oct. 12.) 1800 w.

*26648. Petroleum—The Light of the World (F'y-Oct. 12.) 1400 w.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I-Began May—7 parts to date—45 cts. each).

23443. Sculptured Monuments of Boston. Ill. Frank T. Robinson (Ml N-Began July—5 parts to date—15 cts. each).

24240. On Some Life Zones in the Lower Palæozoic Rocks of the British Areas, as Defined Mainly by Researches during the Past Thirty Years. Henry Hicks (G M-Began Aug. —3 parts to date—30 cts. each).

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng-Began Aug. 10—7 parts to date —30 cts. each).

24997. On a Collection of Jurassic Cephalopoda from Western Australia. Ill. G. C. Crick (Began Sept.—2 parts to date—30 cts. each).

25280. Wood Pulp, and Its Conversion into Paper and Other Products (I & I-Began Sept. 7 —Ended Oct. 12—6 parts—30 cts. each).

25313. The Manufacture of Briquette Fuel. William Colquhoun (I C T-Began Sept. 14—Ended Oct. 5—4 parts—30 cts. each).

25654. Aërial Navigation. A. F. Zahn (J F I-Began Oct.—Ended Nov.—2 parts—45 cts. each).

25664. Letters to Young Engineers. E. G. J. McCudden (J E—Began Sept. 1—3 parts to date—45 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng-Began Oct. 13—3 parts to date—15 cts. each).

26049. An Andean Oasis (E-Began Oct. 12 —Ended Oct. 19—2 parts—30 cts. each).

26050. Some Remarks on Modern Naval Tactics (E-Began Oct. 12—3 parts to date—30 cts. each).

26560. Indiana Industries (Ir Age-Began Nov. 8—1 part to date—15 cts).

COMMENT & CRITICISM

Wealth from Legislation.

MR. WM. NELSON BLACK in his recent timely paper "The Prevailing Jealousy of Wealth" states so many timely truths, that added emphasis may be more useful than criticism ; but he makes one omission that you may find space to correct. He considers the distribution of wealth during the past forty years, but does not mention the increase of legislative activity and interference ; and whether, as would be natural, aggregated capital has not been able to use these added powers for its own particular advantage. If it has, he would find one just motive for the "Jealousy of Wealth" among the many unjust ones that he so rightly condemns.

It is no answer to say that much of this legislation has been procured by other forces than wealth. Its effect is what we must consider.

The question is whether in the Government of to-day the last million of the multi-millionaire (controller or owner) does not have more weight than the single million in other hands. Industrially it should have; but certainly not in the making and administering of statutes. Instances are numerous, but who questions that the weight of aggregated and ready capital has been increased by the Interstate Commerce law, the Illinois elevator statutes and decisions, and the repeated changes in the import tariff.

Mr. Black rightly distinguishes between the *creation* and *accumulation* of wealth, but his examples are not all fortunate. Mr. Gould undoubtedly *created* more millions than he left ; but among the millions he "produced," Mr. Black has overlooked the millions he *created* with a printing press in Erie, and the other millions he *accumulated* by consolidation in various railways.

It appears to me that the unreasoning and unjust feeling toward wealth is founded on the unformulated distinction by the masses of the ethical difference between creation and accumulation.

G. C. HEWETT.

Washington, D. C.

A Technico Legal Puzzle.

I NOTE the remarks in the Department of Electricity (October number) with reference to the destruction of gas and water pipes, cable covers, etc., by the return currents of the trolley roads.

This has been an "open secret," for a long time, among electrical people; but you have spoken and the matter is now public.

The Bell Telephone Company have tried to keep the destructive action away from its cables, by fastening large lead sheets to water and gas pipes and cable covers, that the current might "spread itself," dissolving or corroding the sheet of lead instead of the pipe or sheath. This effort failed utterly; for the sheet of lead was soon honeycombed and destroyed.

Welding the rails to make a good return conductor promises better results, but an open joint must be left at frequent intervals for expansion and contraction. This joint must be bridged, and there you are again, with a defective joint as soon as the weather has had time to act upon it.

You speak of court decisions. Although the telephone companies were on the highways first, this circumstance has not protected them against trolley induction troubles and they have been forced to adopt metallic circuits. Worse than this, in Milwaukee and other cities telephone and telegraph poles and wires had been ordered from the streets as *unsightly obstructions.* Yet, almost in the same breath, permission was given to the electric railway companies to erect their tangle of feed wires, guys, stays, switches and trolley-wires, with at least four times as many poles to each block as were required for the transmission of intelligence.

So long as the destruction of underground property was confined to the cables of telegraph and telephone companies, and the gas companies' pipes, the thrifty citizen looked on with indifference, like Artemus Ward during the rebellion, who was willing to sacrifice all his wife's relations on the altar of his country. But now that the city engineers have discovered that his water pipes are being honeycombed and must be renewed, the taxpayer proposes to have his say; and his voice will be multitudinous and vociferous.

Wouldn't it be funny, if the electric railways in cities were finally forced to fall back upon the poor, despised double trolley? C. H. HASKINS.

New York, 1894.

Theater Building in American Cities.

THE clipping from the "Current Topics" columns of "Electricity" which you were kind enough to send me contains nothing which should modify in any manner the paragraph from my article of "Theater Building in American Cities" quoted and attacked by the author of "Current Topics."

Of course I admit that the substitution of electric lighting for gas removes certain elements of danger, and particularly those enumerated in "Current Topics."

But I do not ignore the imminent danger to dry wood structures from contact with, or close vicinity to overheated electric light wires, which has been the cause of innumerable fires, information and comment about which can be found in the columns of every journal devoted to the interests of the fire underwriters.

If the electrician is disposed to maintain that in a well designed and well constructed system of electric conductors such overheating will not occur, let him remember that the person who will erect a theater of cheap and therefore combustible structural materials will also provide a cheap and therefore probably unsafe system of wiring. But even when it is intended to provide a high grade electric installation, there exists the possibility of an occasional imperfection of material or workmanship or both, which with the cussedness of inanimate things is sure to occur when its existence involves the greatest danger. I therefore stlll maintain that notwithstanding the introduction of electric lighting "there is as much reason as ever why theaters should be built entirely of incombustible material."

DANKMAR ADLER.

Chicago, 1894.

The True Cause of the Lack of Progress in South America.

I WAS much interested in the letter entitled "The Obstacle in Peru" which appeared in a recent number of your Magazine over the signature "N. J. S."

Although I have not visited Peru, I endorse what that gentleman says, as it tallies so exactly with my own experience in another of the South American states, where the conditions appear to be very similar. I have lately returned from the Republic of Colombia, where I spent three years in the service of an English gold mining company. Whilst in that country, I noticed precisely the same state of affairs, and suffered under just those disabilities to which your correspondent referred. Colombia which owes, exclusive of many years' arrears of interest, nearly two million pounds sterling (£2,000,000), chiefly to England, I believe I am correct in saying, yet finds money to pay to the Pope a yearly subsidy of two hundred thousand dollars gold ($200,000) and this with the rate of exchange on the paper currency varying from 150 to 200 per cent. I know, indeed, as a positive fact, ascertained during a recent stay in New York, that the Colombian government has not yet paid the gentleman (an American) who represented them at the late "World's Fair," the remuneration agreed upon for his services. After leaving Colombia, I made a short tour through Mexico where, as is well known, the state has for a considerable number of years been officially dissociated from the church. To any one who happens to be acquainted with both Colombia and Mexico, the enormous superiority of the latter country, in material prosperity and advancement, cannot fail to be apparent. Colombia is, in short, practically run by a handful of Jesuits in Bogota, the capital. I feel sure any impartial American or English observer, who knows the country, will fully bear me out in this statement. In fact, those of the consular agents of both countries with whom I am acquainted, have admitted as much to me as the result of their experience of Colombia. I should like to add that I am not in the least actuated by any motives of religious animosity. Possibly some Colombian may write, refuting my assertions, but—"'Tis true, 'tis pity, and pity 'tis, 'tis true." F. O.

London, Eng., 1894.

American Portland Cement.

In your review of the industrial press for November I note that you make some comments on Mr. Tucker's paper on cements as published in the August *Brickbuilder*, which ends with an unjust criticism on American Portland Cements. The validity of Mr. Tucker's views was attacked in the September and October numbers of the *Brickbuilder* by Prof. Newbury and myself.

That this article was unjust to American Portland Cement can be seen by Mr. Tucker's reply to the writer in the October *Brickbuilder* where he acknowledges that some American Portland cements are (to use his own language) "equal, nay, superior, to the foreign cement," but this is only done after bringing to his attention places where American Portand cement factories have supplied their product for work in which the best foreign cement on the market failed to pass the specifications; and then he insinuates that this cement, served to these particular operations, was especially prepared and different from what the American manufacturer usually places on the market. This, the writer, as a representative of the oldest brand of American Portland cement and the brand used in the operations referred to, wishes to emphatically deny. This brand of cement is the same to-day, anywhere it is found, and is always the best that can be produced in any country.

I am well aware that there are many engineers who have the same opinion as Mr. Tucker about American cement and that is the reason the writer takes this matter up. There are about twenty-five importers of foreign cement to one manufacturer of American cement, and it is the business of these importers to try to discredit the quality of American Portland cement. Some do it honestly. Having been told by a manufacturer in Europe that his cement was "the best in the world," they naturally conclude that it must be better than the American cements, and not wishing to be better informed, they remain uninformed till they meet some engineer who, not satisfied with what has been told him by importers, makes a long and careful series of tests, with both American and foreign cements, the results of which show that many of the Belgian and English Portlands are of a lower quality than any American brand, and that the bulk of the American brands are equal to the very best of the German, French or Danish.

Unfortunately for the American Portland cement industry, very few engineers in the past have had the time or the facilities to carry out such tests, but the uses to which Portland cements are now put, are such that a careful engineer must make tests and find out exactly what he is using.

If Mr. Tucker made any tests that would warrant a man to make the assertions he has made about American Portland cement, or to substantiate his insinuation that the German cements are of a more uniform quality than the American cements, the writer would like to see them published at some early date. He gave no data in the article appearing in the *Brickbuilder*.

WM. G. HARTRAUFT.

Philadelphia, Pa., Nov. 13, 1894.

NEW BOOKS OF THE MONTH

Electric Lighting Plants; Their Cost and Operation. Data Compiled from Station Reports of Electric Lighting Plants Employing Overhead Circuits, With Suggestions Pertaining to the Information Usually desired by the Non-Technical Purchaser. By W. J. Buckley. Sold by Ft. Wayne Electric Corporation. [Paper. 12mo, 275 p., with diagrams and folding plans. $2.]

"Now what I want is Facts. . . Facts alone are wanted in life. Plant nothing else and root out everything else. You can only form the minds of reasoning animals upon Facts; nothing else will ever be of any service to them. . . .Stick to Facts, sir!" If the above quoted observations of Thomas Gradgrind ever had a more pat application to any condition of affairs than it has at the present day to the electric-lighting business, it would surely be a matter of difficulty to point it out. We have had more than enough works on the subject of electric lighting; the electrician's book-shelves fairly groan under them, but when the intending purchaser of an electric-light plant seeks in them for Facts, he is liable to meet with disappointment. But in this work of Mr. Buckley's he will find most of the Facts he has hitherto sought in vain, and bottom-facts at that. The subject-matter is confined to arc and alternating incandescent plants of comparatively moderate size; the maximum in the former case being a 2000 candle-power, and in the latter a 3000 light plant. It is difficult to imagine any possible question relating to the cost of construction, maintenance or operation of this class of electric plants, which is not clearly and completely answered in this work. The prices are given in all cases; not "list" prices, but net prices; the actual prices of to-day, and not of last year or the year before. This is a subject on which the author is evidently at home, inasmuch as he informs us in his preface that he has been in active service as a salesman for a well-known electrical manufacturing corporation for nearly ten years. It would take too much space to attempt to enumerate the contents of the book; it is enough to say that it is full to repletion with information of the utmost value to central-station managers as well as purchasers and owners, most of which is not to be found elsewhere in print. Numerous tables, charts and diagrams accompany the text, and there is also an especially valuable series of plans of American central-stations actually in operation, accompanied with brief criticisms pointing out their several excellencies and defects. In the appendix are the rules of the Chicago Underwriters' Association; the National Electric Light Association; Mr. Ayer's excellent instructions to employés, and other useful matters of like nature.

Central Station Bookkeeping and Suggested Forms. With an Appendix for Street Railways. By Horatio A. Foster, Mem. A. I. E. E. New York: The W. J. Johnston Co., Ltd., 253 Broadway. [Cloth. 139 pages, 76 forms and diagrams. Price $2.50.]

Until data relative to itemized cost of the electric distribution are collected, it will be difficult to judge how little most station managers know about details. Most of the large low tension stations keep records of accurate data, but high tension stations, both arc and alternating incandescent, seldom do this. By small stations all such records are neglected.

The importance of such records of operation and cost can scarcely be exaggerated. No central station manager is well prepared to do business in times of close competition with gas and other companies, until he knows the itemized cost of supplying the electric current. To enable him to reach this desirable information with minimum labor this work has been written, and the well-known name of the author gives assurance that the work may be consulted with confidence.

The book contains diagrams for the organization of the staff of electrical central stations, and a classification of accounts and reports, including sample forms for every department. As the name indicates, the work is devoted mainly to the accounting department, both of central stations and street railways, and outlines a complete scheme for its organization and routine which will enable the management to determine at any moment the condition of business, and particularly the unit cost of the generation and distribution of current. In an appendix is furnished a classification of accounts of electric street railways, together with instructions, forms of books, etc., necessary to carry it out.

NOTES ON THE VENTILATION AND WARMING OF HOUSES, Churches, Schools and Other Buildings. By the late Ernest H. Jacob, M. A., M. D., Professor of Pathology in Yorkshire College, Leeds. New York: E. & J. B. Young & Co. [Cloth, 16mo, 124 p. Illustrated. 25 cents.]

THIS volume forms one of the series of manuals of health originally issued by the Society for Promoting Christian Knowledge, and is now reprinted by the Youngs for the American public. It is not a highly technical work from the strictly engineering point of view, nor is it designed as a treatise on hygiene for the use of medical officers of health and sanitary experts, though even experts will find much of interest in it; but it is planned for the use of the general householder no less than for those more closely interested in the sanitation of buildings. The author will be remembered as an expert having wide experience in examining and dealing with insanitary buildings.

THE ENCYCLOPEDIA OF FOUNDING AND DICTIONARY OF Foundry Terms Used in the Practice of Moulding. By Simpson Bolland, Practical Moulder and Manager of Foundries; Author of "The Iron Founder." New York: John Wiley & Sons.

THE character of this book, so far as its purpose is concerned, is sufficiently indicated by its title, which purpose seems to have been well achieved in the body of the work. The book contains 535 pages, and is a valuable edition to the technological literature of foundry work. The author is a well known and accomplished writer upon the art of founding and subjects connected therewith and to those acquainted with his previous works no other recommendation of his present treatise will be needed.

HENDRICKS' ARCHITECTS AND BUILDERS' GUIDE AND Contractors Directory of America, for 1894-95. New York: Samuel E. Hendricks Co., No. 61 Beekman street. [Cloth. 8vo. xxx-709 p. $5.]

THIS annual publication, embracing this year over 170,000 names allied with the construction industries of the country, merits commendation for its completeness, accuracy, and good arrangement. It is a book of great value to the classes named in its title as printed above, and also for manufacturers or dealers in material of every kind required in building. The names and addresses given are classified both as to States and as to the occupations and materials referred to.

BOOKS RECEIVED.

Halliday, George.=Belt Driving. Illustrated. New York: Spon & Chamberlain. [Cloth. 8vo. 100 p. $1.50.]

Jackson, Frank G.=Theory and Practice of Design: an advanced text-book on decorative art. Illustrated. Philadelphia: [imported by] J. B. Lippincott Co. [Cloth. 8vo. $2.50.]

Johnson, Emory R.=Relation of Taxation to Monopolies. Philadelphia: American Academy of Political and Social Science. [Paper. 8vo. 67-93 p. 25 cents.]

Johnson, F. R.=Stresses in Girder and Roof Trusses for Both Dead and Live Roads. Illustrated. New York: Spon & Chamberlain. [Cloth. 12mo. 215 p. $2.50.]

Kitchen-Boiler Connections; practical letters and articles relating to water-backs and range-boilers compiled from the *Metal Worker*. Illustrated. New York: David Williams. [Cloth. 8vo. 6-129 p. $1.]

MacFadden, Charles K., *and* Ray, William D.=The Practical Application of Dynamo-Electric Machinery. Illustrated. Chicago: Date & Ruggles. [Cloth. 16mo. 167 p. $1.]

Medicus, Ludwig.=Qualitative Analysis: for use in instruction in chemical laboratories. Translated by John Marshall. Philadelphia: [imported by] J. B. Lippincott Co. [Cloth. 8vo. $1.50.]

Poor, H. V.=Poor's Manual of the Railroads of the United States for 1894. (Twenty-seventh year.) New York: H. V. & H. W. Poor. [Cloth. 8vo. 1800 p., 70 maps. $7.50.]

Roberts, Charles W.=Practical Advice for Marine Engineers. Illustrated. New York: Spon & Chamberlain. [Cloth. 12mo. 150 p. $1.]

Smith, Edgar F.=Electro-chemical Analysis. Illustrated. (Second edition.) Philadelphia: P. Blakiston, Son & Co. [Cloth. 12mo. 143 p. $1.25.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

The Hawley Down Draft Furnace Company, Chicago, Illinois, U. S. A.=Descriptive pamphlet of Hawley Down Draft Furnace System, pink and gold cover, 50 p. [The descriptive text is illustrated by colored lithographic plates, the whole being printed in the most elegant manner. There are eight of these colored plates and 129 engravings, illustrative of buildings in which this system has been installed, and also of the installments themselves, among which a conspicuous example is that of a 4000 horse-power plant in process of erection at the Harrison street station of the Chicago Edison Company. The completed boiler plant at this station will aggregate 20,000 horse-power. A full exposition of the system is given with a long list of tests for determination of economical results. These economical results are obtained by smoke prevention. The system demonstrates that smoke can be prevented and money saved. Many valuable tables are contained in the pamphlet. Among these are a number showing results of tests made with different types of boilers which have been fitted with the Hawley Down Draft Furnaces which cannot fail to be of great interest to steam engineers. A table of cost of evaporating 1000 pounds of water by the use of coal as fuel, also a table showing cost of evaporating 1000 pounds of water with different grades of fuel and varying evaporations, also another giving cost of evaporating 1000 pounds of water, per pound of oil, another giving approximate cost of the labor required in evaporating 1000 pounds of water with coal as fuel, another giving approximate cost of labor required in evaporating 1000 pounds of water when oil is used as fuel, a code of rules for boiler tests recommended by the American Society of Mechanical Engineers, a table of data to be obtained in testing steam boilers and reporting the trial with a form for reducing these data, and making a record of the tests, a table of sizes of chimneys with appropriate horse-power of boilers, three pages of practical and useful information for steam users, two of editorial comment, testimonials, and a long list of steam plants equipped with Hawley furnaces, are comprised within the limits of this very complete and well prepared pamphlet.]

Neptune Meter Company, New York, U. S. A.=(1) Descriptive Pamphlet of the Trident water meter, 31 p. Cover buff, green and gold. [A beautifully printed trade publication. Topics noted in the margin of pages. Is a full exposition of the construction and operation of this water meter. (2) A Communication of General Interest in Regard to Disk Actions, 5 p. (3) Having Reference to Oscillating Disk Actions, 22 p. (4) A Mascot, 4 p. (5) On Ice, and the Dynamics of Frost as Affecting Water Meter Practice, 13 p. (6) Compound Action, 14 p. Describes and illustrates a new system of spur gearing used in the Trident Water Meter compound gear train. Each of these belong to the Trident Water Meter Series. Copyright, 1894.]

The Lunkenheimer Co., Cincinnati, New York. U. S. A., London.=Illustrated Catalogue and Price List, 1895. Brass and Iron Valves, Lubricators and Steam Specialalties. 107 p. [Contains descriptions and prices of an extensive line of goods.]

New Jersey Car Spring and Rubber Co., Jersey City and New York, U. S. A.=84 p. [Gives descriptions and illustrations of nine regular styles of hose aside from fire hose, to wit, "Staple," "Hudson," "Reliable," "Red Jacket," "Pearl," "Emerald," "Extra Pará," "Special," and XX Special," and also of an extensive line of other rubber goods, with price lists. Contains also blank memorandum pages.]

Consolidated Car-Heating Co., Albany, N. Y., U. S. A.=Advance Sheets, Part XII, 1895 edition. Electric Heaters. 31 p. [Other parts sent on application.]

Smith and Winchester Co., Boston, Mass., U. S. A.=21 p. [Describes the Winchester Steam and Hot Water Heating Boilers. Beautifully printed in tints, and contains sizes, capacities and prices.]

Carson Trench Machine Co., Charlestown, Boston, U. S. A.=Catalogue C. 37 p. [Concerning the Carson-Lidgerwood Cableway, introduced as "Trainor's Cable System" for excavating and refilling all kinds of trenches. Beautifully printed with elegant illustrations of numerous instances of work in progress wherein the system and its operation are exemplified.]

U. S. Heater Co., Detroit, Mich., U. S. A.= Warmth for Winter Homes. 75 p. [An essay on Domestic Heating, heating of greenhouses, schools, hospitals, baths, etc. Also containing descriptions of the Capitol Heater for hot water and steam, with sizes, capacities and prices, and report of an expert on the same. Also containing descriptions of the "Hecla" and "Mascot" Heaters, with sizes and prices. 79 p. Beautifully illustrated with engravings of residences and other buildings in which the heaters manufactured by this company have been placed.]

The Electric Boiler Co., Rochester, N. Y., U. S. A.=38 p. [Describes and illustrates the construction and use of the "Electric Boiler," with table of sizes, capacities, etc., and price list.]

G. A. Crosby & Co., Chicago, Ill., U. S. A. =4th edition Catalogue of Prices, Dies and Special Machinery for Sheet Metal Workers. 188 p. [Illustrations of Machines and Tools, with descriptive text, sizes, capacities, weights, etc.]

Westinghouse Electric and Manufacturing Co., New York, Boston, Chicago, Charlotte, Philadelphia, St. Louis, San Francisco, Portland and Syracuse, U. S. A.=1. "Stopper Incandescent Lamp." 27 p. [Statement of the use and economy of this lamp at the World's Fair. Illustrations of the lamp and of processes used in its manufacture and the adapters best suited for use with different sockets.]

For additional Catalogues see "Improved Machinery," page 32.

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SILVER COINAGE HISTORICALLY CONSIDERED.

By Henry Dunning MacLeod.

IN the September *Nineteenth Century* Mr. J. P. Heseltine makes an appeal to monometalists to give a statement of the reasons for the faith which is in them. I propose in the following remarks to give a very brief and concise account of the facts and arguments on which our present system of monometalism is founded.

Charlemagne established the system of coinage which was adopted throughout western Europe. He made the pound weight of silver the standard, and divided it into 240 pieces called pennies. For a considerable period the kings of France coined these pennies at their full weight and fineness. But about the beginning of the twelfth century they began not only to diminish their weight, but to debase their purity. They considered it part of their inalienable divine right to declare that their subjects should accept the diminished and debased coins at the same value as the good coins of full weight. They further complicated matters by issuing gold coins, and they considered it as part of their divine right to change the rating of these coins with respect to each other as often as they pleased.

These constant tamperings with the coinage produced commotions and disturbances, and drove away foreign trade from the country. At length that great sovereign, Charles the Fifth, justly surnamed the Wise, perceived that the only way to restore prosperity to the country was to reform the coinage. He referred the matter to one of his wisest and most trusted councillors, Nicolas Oresme, who, in answer to the appeal of his sovereign, drew up his now famous *Traictie de la première invention des Monnoies*, in twenty-six chapters.

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After explaining the true nature and uses of money, he laid down the following principles :

1. That the sovereign has no right to diminish the weight, debase the purity, or change the denomination of the coinage. To do so is robbery.

2. That the sovereign can in no case fix the value or the purchasing power of the coins. If he could do so, he could fix the value of all other commodities ; which was indeed the idea of mediæval sovereigns.

3. That the legal ratio of the coins must strictly conform to the relative market value of the metals.

4. That if the fixed legal ratio of the coins differs from the natural or market value of the metals, the coin which is underrated entirely disappears from circulation, and the coin which is overrated alone remains current.

5. That if degraded and debased coin is allowed to circulate along with good and full-weighted coin, all the good coin disappears from circulation, and the base coin alone remains current, to the ruin of commerce.

This great treatise, which may be said to stand at the head of modern economical literature, contains the fundamental principles of money which are now accepted by all sound economists ; and it was out of these principles that the system of monometalism was developed at the close of the seventeenth century.

The same ideas and evils existed all through Europe, and were called *morbus numericus*.

Poland, which then comprehended the modern Prussia, was afflicted with these evils. Sigismund the First, King of Poland, sought the advice of Copernicus, who was a member of the Prussian Diet. At the instance of Sigismund, Copernicus drew up a masterly treatise on money, which he entitled *Ratio monetæ cudendæ*, which has only been discovered within the present century, and is included in the magnificent edition of his works printed at Warsaw in 1854.

Copernicus had no knowledge of the treatise of Oresme, written 160 years before his time, but he came to exactly the same conclusions. They were :

1. That it is impossible for the prince to regulate the value of the coins, or of any other commodity.

2. That all the prince or the law can do is to maintain the coins at their full legal weight, purity, and denomination.

3. That it is robbery for the prince to change the denomination, diminish the weight, or debase the purity of his coins.

4. That it is impossible for good full-weighted coin and base and

degraded coin to circulate together; that all the good coin is hoarded, melted down, or exported, and the degraded and debased coin alone remains in circulation.

5. That the coins of gold and silver must bear the same ratio to each other as the metals do in the market. Oresme and Copernicus quite agreed that it is impossible to keep gold and silver coins in circulation together in unlimited quantities at a fixed legal ratio differing from the market value of the metals.

6. That when good coins are issued from the mint, all the base and degraded coins must be withdrawn from circulation; or else all the good coins will disappear, to the ruin of commerce.

The early English sovereigns did not debase their coinage, but immense quantities of base and degraded coins were in circulation, and consequently all the good coin disappeared as soon as it was issued from the mint. Edward the First was the first to diminish the weight of the coin. He coined 243 pennies out of the pound weight of silver, and by successive diminutions the pound weight of silver was coined into 744 pennies under Elizabeth. The instant disappearance of the good coin as soon as it was issued from the mint was the subject of repeated debates in Parliament for some centuries, and was an inscrutable puzzle to financiers and statesmen.

At last Sir Thomas Gresham explained to Queen Elizabeth that good and bad coin cannot circulate together, but that the good coin disappears, and the bad coin alone remains current. As Sir Thomas Gresham was the first in this country to explain that permitting bad coin to circulate was the cause of the disappearance of the good coin, I suggested in 1858 that this should be called Gresham's law, which name has now been universally accepted. But as Oresme and Copernicus had both declared this law before him, it ought to be called the law of Oresme, Copernicus, and Gresham.

This great fundamental law of the coinage soon became common knowledge. It is thus stated in a pamphlet in 1696:

"'When two sorts of coin are current in the same nation of like value by denomination but not intrinsically [*i. e.*, in market value], that which has the least value will be current, and the other as much as possible will be hoarded,' or melted down, or exported, we may add."

This great fundamental law of the coinage has been found to be universally true. Henceforth it was recognized and acknowleged in all subsequent discussions on the coinage. It applies in the following cases:

1. If the coins consist of one metal only, and clipped, degraded, and debased coins are allowed to circulate together with good coins, all the good coins disappear: they are either hoarded, or melted down, or exported, and the bad coin alone remains in circulation.

2. If coins of two metals, such as gold and silver, are allowed to circulate together in unlimited quantities at a fixed legal ratio which differs from the market ratio of the metals, the coin which is underrated disappears from circulation, and the coin which is overrated alone remains current.

3. As a necessary corollary, it follows that it is impossible to maintain a fixed par of exchange between countries which use different metals as their standard unit.

This law is not confined to single and separate States ; it is not limited in time or space ; it is absolutely universal : and it is equally impossible for the whole world to maintain coins of two or more metals in circulation together in unlimited quantities at a fixed legal ratio which differs from the natural, or market, value of the metals, as it is for single and separate States to do so.

The explanation of this problem, which was an inscrutable mystery to statesmen and financiers for so many ages, is extremely simple. If shillings are allowed to circulate together, some of which are worth twelvepence and others only ninepence, and every one is allowed to pay his debts in which of them he pleases, he will naturally pay his debts with the shillings worth ninepence and keep the shillings worth twelvepence in his pocket. Or, if shillings worth twelvepence have no more value than shillings worth ninepence, bullion-dealers collect all the heavy coins they can and melt them down into bullion, in which form they have more value, or they export them to foreign countries where they have their full value. Thus the underrated coins have invariably been found to disappear in one or other of these three ways.

It is exactly the same in all cases in which persons are allowed to pay their debts in things which have nominally the same value, but in reality are of different values. When persons are allowed to pay their rents in kind, they naturally select the worst portions of the produce to pay their landlords, and keep the best portions for themselves.

If merchants received an order for so many yards of cloth, and the law allowed two different yard measures to be used,—one of three feet and one of two feet,—merchants would naturally fulfil their orders in yards of two feet rather than in yards of three feet. It is only natural that persons should pay their debts in the cheapest form to themselves.

So, if the law allows debtors to pay their debts in coins of different metals which are rated equally in law, but whose values differ in the market of the world, they will naturally pay their debts in the coin which is overrated, and keep the coin which is underrated at home. Then inevitably the coin which is underrated disappears from circulation, and the coin which is rated above its natural or market value alone remains current ; and this is true whether single and separate

States do so, or whether the whole world does so. If, then, the whole world were to agree to rate a coin below its market value, it would inevitably disappear from circulation; for the whole world can no more by universal agreement make nine equal to twelve than any separate States can.

The bimetalists contend that, if a fixed ratio between the metals were established by international agreement, the market value of the metals would conform to it; that by so doing the metals would circulate together in unlimited quantities at the fixed ratio, and so augment the currency or circulating medium of the world; that every one would bring his gold and silver to be coined; that these might be used indifferently in the payment of debts, and that a stable ratio of exchange might be established between all nations.

Most unfortunately, the experience of bimetalism in every country for five hundred years entirely negatives all these allegations.

1. It is proved that the fixed legal ratio between the coins never had the slightest effect on the relative market value of the metals.

2. That when the fixed legal ratio between the coins differed from the relative market value of the metals, the coins of that metal which was underrated invariably disappeared from circulation, and the coins of the metal which was overrated alone remained current; and that, as the market value of the metals changed, gold and silver alternately drove each other out of circulation, so that there was no augmentation of the currency, but one metal simply displaced the other.

3. That when one metal is at a premium,—*i. e.*, its market value exceeds the legal ratio,—no private persons bring that metal to be coined, because it would be simply to diminish the value of that metal. The master of the mint stated in 1816 that during the whole of the reign of George the Third no more than £64,500 of silver was coined, because during all that period silver had been at a premium.

The bimetalists are energetically urging governments to adopt their doctrines. Well, we have two examples of the ideal condition of the bimetalists, and we shall see with what results.

In 1666 it was enacted that all persons might bring their gold and silver to the mint to be coined free of all charge. By the mint indentures the gold guinea was coined to be of the value of 20s. in silver, but no legal ratio was fixed between the coins; the public were to receive them at such a rating as they pleased. Guineas, instead of being current at 20s. according to the mint indentures, passed current at 22s. The silver coins became constantly more degraded, until at last they were clipped down to half their weight. After the great recoinage by William the Third, guineas were successively reduced by proclamation, and a treasury warrant fixed that they should be received at the rate of 21s. 6d. at the treasury. But still all the good silver coin disappeared from circulation as soon as it was issued from the mint. In their perplexity the government referred the whole matter to Newton, who showed that the true value of the guinea was only 20s. 8d., according to the market value of the metals, and that in consequence of this all the good silver was at once exported. He recommended that the guinea should be reduced to 21s. by way of experiment. This was accordingly done; but the guinea was still overrated by 4d., and the consequence was that there was no good silver in circulation during the whole of the century. It then became an established custom among merchants that all obligations became payable in gold only, as the cheaper metal. The foreign exchanges were settled in gold; so ever since 1718 England has become a gold monometalic country, and in public estimation the standard was changed from silver to gold, although the obsolete and effete words of bimetalism lingered on in the statute-book for another hundred years. At the great recoinage of 1816, that which had become established by mercantile usage was enacted by law. Gold was adopted as the sole standard, and silver was coined only in limited amounts, and made legal tender for only 40s. Ever since then England has enjoyed the most perfect system of coinage ever devised by the ingenuity of man, and has been perfectly free from all coinage troubles.

I will now take the case which the bimetalists cite as the golden age of bimetalism. France endeavored to maintain bimetalism from 1113 to 1874. But during that time the mint price of the marc of gold has been changed 146 times, and the mint price of the marc of silver 251 times, and the changes of the rating between gold and silver were innumerable; at last, in 1726, the ratio of gold to silver was fixed at 1 to 14½. But silver was rated too highly, and by the same law that gold became the standard in England silver became the standard in France. In 1803 the ratio of gold to silver was fixed at 1 to 15½, at which it still nominally remains. Gold and silver coins were made equally legal tender at that ratio. But the French liberating armies plundered all the sanctuaries of the countries they came to liberate of their treasures. Vast quantities of silver were coined, and the market ratio of silver to gold became 17 to 1. Thus gold was at a premium from 1803 to 1850, and consequently there was no gold in general circulation during that period. I myself can testify that in 1839 there was scarcely a gold coin to be seen in common circulation in France. There was of course plenty of gold coin to be had at the Bank of France, but those who wanted it had to pay a premium for it.

Soon after 1850 the gold supplies came in from California and Australia, and the market ratio of silver to gold, which was 15¾ to 1, rose to 15⅓ to 1; and that apparently slight change in the market ratio, while the legal ratio remained at 15½ to 1, was sufficient to displace from 150,000,000 to 200,000,000 of silver and to substitute an equal quantity of gold for it. I was residing at a French seaport town in 1857, and every steamer that came in was loaded with casks of Scotch whiskey going to be transmuted into French brandy, and every steamer that went out had its deck piled with bags of five-franc pieces. It was the same at every other port. Silver departed from France in a flood, and at length became so scarce that it became necessary to coin those detestable five-franc gold pieces. This case shows the immense practical importance of even a very slight difference between the legal ratio and the market ratio of gold and silver, and decisively negatives the allegation of the bimetalists that gold and silver can circulate together in unlimited quantities at a legal ratio differing from the market ratio.

In 1865 the Latin Union was formed, but even then Italy declared herself in favor of a single gold standard. In 1867 the value of silver began to fall and to create uneasiness. A commission was appointed, which by a majority declared against the adoption of a single gold standard. In 1868 the fall became more accentuated, and a commission by a majority declared in favor of a single gold standard. Another commission in 1869-70 reported still more strongly in its favor. In June, 1870, Prussia appointed a commission to consider the expediency of adopting a single gold standard, but the war of 1870 put an end to all these discussions. By acts of 1871 and 1873 Germany adopted a single gold standard. In December, 1872, Belgium adopted a single gold standard. The matter then became still more pressing, and a great debate was held at the Société d'Economie Politique, in which the government was represented by M. de Parieu. The majority strongly decided on the necessity of adopting a single gold standard. In accordance with this resolution, France closed her mints to the free coinage of silver in 1874, and became a gold monometalic country. The bimetalists persistently assert that it was the closing of the French mints in 1874 that caused the fall in the value of silver, whereas it was exactly the contrary. It was the fall in the value of silver which compelled the closing of the mints to the free coinage of silver, and its necessity was foreseen six years before it took place, and it was only done after the fullest discussion and in accordance with the advice of the highest authorities.

I have now to lay before your readers an instance which is perfectly novel to the general public. As the East India company extended its dominion it was greatly plagued and tormented by the multiplicity of gold and silver coins—994 in number—which were in circulation in

India of different weights and fineness. In 1766 they endeavored to establish bimetalism, but it entirely failed. In their perplexity they sought the advice of Sir James Steuart, who was the ablest economist in England before the publication of the "Wealth of Nations" in 1776. In 1772 he drew up a treatise on money for them, showing, in exact accordance with all the preceding authorities since Oresme, that it is impossible that gold and silver can circulate together in unlimited quantities at a fixed legal ratio differing from the market value of the metals. In 1805 Lord Liverpool's great master treatise on the subject was published, and as soon as it reached India, in 1806, the governor-general in council took it into consideration, and issued a minute to the subordinate governments condemning bimetalism in the strongest terms, and declaring its entire adhesion to the doctrines of Lord Liverpool. By the courtesy of the India office I am enabled to make this minute public for the first time. It said :

"A proportion between the gold and silver coins is fixed by law according to the value of the metals, and it may be on the justest principles, but, owing to a change of circumstances, gold may become of a greater value in relation to silver than at the time the proportion was fixed ; it therefore becomes profitable to exchange silver for gold ; so the coin of that metal is withdrawn from circulation ; and if silver should increase in its value in relation to gold, the same circumstances would tend to reduce the quantity of silver coin in circulation. As it is impossible to prevent the fluctuations in the value of the metals, so it is equally impracticable to prevent the consequences thereof in the coins from those metals. . . .

"But there is a radical defect in the principle itself of giving a fixed value to metals in coin that in their nature are subject to continual change."

The minute then declared the unhesitating adhesion of the council to the principle that one metal only should be adopted as the standard unit, though coins of other metals might circulate at their market value. The minute decided that silver should be the sole standard, which was perhaps natural under the circumstances. But the error was most unfortunate, and, having been carried out by Lord Dalhousie with the extremest severity by the total demonetization of gold, has been the cause of all our present troubles.

The principles first declared by Petty, Locke, and Harris, and fully developed by Lord Liverpool, which received the adhesion of the Indian government in 1806, that one metal only should be adopted as the standard, and that subsidiary coins of other metals might be issued in limited quantities and made legal tender only for small amounts, were adopted by the British government in 1816.

Bimetalists now admit that no single country can maintain bimetalism by itself; but they allege that, if all nations of the world, or at least the principal of them, were to agree to fix a common ratio, that would maintain a fixed value between them and bring about a stable exchange between all nations. But such ideas are a delusion. When great laws of nature are once proved, they operate throughout the whole world, and not on single countries only. An international agreement can no more make nine equal to twelve than any single country can. If an international agreement were made that the ratio between gold and silver should be 1 to 15½, when the market ratio was 1 to 35, the simple result would be that all debtors would discharge their debts at 10s. in the pound, gold would entirely disappear from circulation, and silver would be the sole metalic currency of the world.

In 1830 Mr. Attwood brought forward a motion to reëstablish bimetalism. Silver had then fallen only 5 per cent., so that Mr. Attwood's plan would have declared 19s. in silver equal to 20s. in gold. But Mr. Herries, master of the mint, Mr. Huskisson, and Sir Robert Peel unanimously declared that such a thing would bring on a national bankruptcy in twenty-four hours. Sir Robert Peel said: "The notion of a double standard was totally fallacious; . . . all would turn to confusion, and public ruin must be the consequence." The motion was negatived without a division.

The bimetalists tell us that bimetalism would lead to a golden age of boundless prosperity; Mr. Herries, Mr. Huskisson, and Sir Robert Peel tell us that it would land us in national bankruptcy in twenty-four hours. Which of these parties will sensible men believe?

The bimetalists tell us that a legal ratio between gold and silver was maintained both in England and France for centuries. What they say is true in the letter, but utterly false in the spirit. They would have us believe that this had the effect of keeping the market value of the metals at that rate, and that both metals remained in circulation together at the fixed ratio. It is true that bimetalism was printed in the statute-books of both countries for centuries, but it was invariably found that the metal which was overrated invariably drove out the metal which was underrated from circulation, and alone remained current. Under the law of bimetalism the two metals never circulated together in any country. So far from the fixed legal ratio governing the value of the metals, governments had, from time to time, to alter the legal ratio, so as to conform to the market ratio, and all civilized governments have now seen the necessity of abandoning this fallacy, and of conforming themselves to the demonstrated laws of nature.

PRACTICAL SCIENCE

Bimetalism is only part of a system which prevailed in every country for centuries. Statesmen thought that they could regulate the value of commodities by law, and the statute-book contained many such laws. But experience showed that such laws were absolutely inoperative, and, after having been abandoned in practice, were at length expunged from the statute-book. The attempt to restore bimetalism is simply the endeavor to revive this exploded economic fallacy.

If it were possible to establish a fixed ratio between gold and silver by international agreement, it would be equally possible to fix the value of all commodities. Innumerable mercantile catastrophes are caused by the unexpected change in the value of commodities; why not then fix the value of all commodities, and so remove the cause of multitudes of mercantile calamities?

Agriculturists are suffering the extremest depression from the fall in the value of their produce. Why not then fix the value of corn at a remunerative price by international agreement? If it were printed in all the statute-books of the world that the price of wheat should be 60s. a quarter, does any person of common sense suppose that the price of wheat would rise one farthing?

It was formerly found impossible to fix the value of the metals, or the value of inconvertible paper money, by laws sanctioned by the direst penalties; how then can it be possible to do so by merely printing so many words in a book?

Mr. Heseltine complains of the paucity of writers in favor of monometalism. But there is no need of a multitude of writers on the subject. The indubitable historical facts which prove the impossibility of bimetalism are contained in the histories of the coinage of every country of Europe for five centuries. And the monumental works of Oresme, Copernicus, Gresham, Petty, Locke, Newton, Harris, Lord Liverpool, the minute of the government of India in 1805, and the decision of the British government in 1816, contain, among many others, the arguments against bimetalism and in favor of monometalism which are unanswered and unanswerable. There is nothing to be added to what they have already said, and their arguments can gain no additional strength by being repeated by scores of writers. Neither do fallacious assertions become true by being repeated a multitude of times.

Moreover, every government in Europe, after having vainly attempted to maintain bimetalism for five centuries, has abandoned it as impracticable and injurious, and adopted monometalism. This course of statesmen, who are responsible for the administration of great States, is of infinitely more worth than any number of writers.—*Nineteenth Century*

MODERN THEORIES AS TO ELECTRICITY.

By Henry A. Rowland.

IT is not uncommon for electricians to be asked whether modern science has yet determined the nature of electricity, and we often find difficulty in answering the question. When the latter comes from a person of small knowledge which we know to be of a vague and general nature, we naturally answer it in an equally vague and general manner ; but when it comes from a student of science anxious and able to bear the truth, we can now answer with certainty that electricity no longer exists. Electrical phenomena, electrostatic actions, electromagnetic actions, electrical waves,—these still exist and require explanation ; but electricity, which, according to the old theory, is a viscous fluid throwing out little amoeba-like arms that stick to neighboring light substances and, contracting, draw them to the electrified body, electricity as a self-repellant fluid or as two kinds of fluid, positive and negative, attracting each other and repelling themselves,—this electricity no longer exists. For the name electricity, as used up to the present time, signifies at once that a substance is meant, and there is nothing more certain to-day than that electricity is not a fluid.

This makes the task of one who attempts to explain modern electrical theory a very difficult one, for the idea of electricity as a fluid pervades the whole language of electrical science, and even the definitions of electrical units as adopted by all scientists suggest a fluid theory. No wonder, then, that some practical men have given up in despair and finally concluded that the easiest way to understand a telegraph line is to consider that the earth is a vast reservoir of electrical fluid, which is pumped up to the line wire by the battery and finally descends to its proper level at the distant end. Is not this the proper conclusion to draw from that unfortunate term "electric current"? Remembering this fact,—that we cannot yet free ourselves from these old theories, and exactly suit our words to our meaning,—we shall now try to understand the modern progress in electrical theory.

This whole progress is based upon something in the human mind which warns us against the possibility of attraction at a distance through vacant space : Newton felt this impossibility in the case of gravitation, but it is to Faraday that we must look principally for the idea that electrical and magnetic actions must be carried on by means of a medium filling all space and usually called the ether. The development of this idea leads to the modern theory of electrical phenomena.

Take an ordinary steel magnet and, like Faraday, cover it with a sheet of paper, and upon this sprinkle iron filings. Mapped before us we see Faraday's lines of magnetic force extending from pole to pole. We can calculate the form of these lines on the supposition that a magnetic fluid is either distributed over the poles of the magnet or on its molecules, assuming that attraction takes place through space without an intervening medium. But at this idea the mind of Faraday revolted, and he conceived that these lines, drawn for us by the iron filings, actually exist in the ether surrounding the magnet; he even conceived of them as having a tension along their length and a repulsion for one another perpendicular to their length.

Two magnets, then, near each other, become connected by these lines, which, like little elastic bands always pulling along their length, strive to bring the magnets together. These so-called lines of force (now called tubes of force) were, by his theory, conducted better by iron and worse by bismuth than by the ether of space, and so gave the explanation of magnetic attraction and diamagnetic repulsion.

The same theory of lines of force was also applied by Faraday to electrified bodies, and thus all electrostatic attractions were explained. By this idea of lines of force it will be seen that Faraday did away with all action at a distance and with all magnetic and electrical fluids, and substituted, instead, a system in which the ether surrounding the magnet or the electrified body became the all-important factor and the magnet or electrified body became simply the place where the lines of force ended: where a line of magnetic force ended, there was a portion of *imaginary* magnetic fluid; where a line of electric force ended, there was a portion of *imaginary* electric fluid. As the quantities of so-called plus and minus electricity in any system are equal, we can thus imagine every charged electrical system to be composed of a group of tubes of electrical force (more strictly electric induction) which unite the plus and minus electrified bodies, each unit tube having one unit of plus electricity on one end and one unit of minus electricity on the other. The tension along the tube explains the reason why such an arrangement acts as if there were real plus and minus electrical fluids on the ends of the tube, attracting one another at a distance. Consider a plus electrified sphere far away from other bodies. The lines of force radiate from it in all directions, and, being symmetrical around the sphere, they pull it equally in all directions. Now bring near it a minus electrified body, and the lines of force turn toward it and become concentrated on the side of the sphere toward such a body. Hence the lines pull more strongly in the direction of the negative body, and the sphere tends to approach it.

In the case of a conducting body the lines of force always pass outwards perpendicularly to the surface, and hence, if we know the distribution of the lines over the surface, or the so-called surface density of the electricity, we can always tell in which direction the body tends to move. It is not necessary to know whether there are any attracting bodies near the conductor, but only the distribution of the lines. These lines then do away with all necessity for considering action at a distance, for we only have to imagine a kind of ether in which lines of force with given properties can exist, and we have the explanation of electric attraction.

But the question now arises as to how the lines of electric force can be produced in the ether, or, in other words, how bodies can be charged.

In the first place we know that equal quantities of plus and minus electricity are always produced. As an illustration, suppose it is required to charge two balls with electricity. Pass a conducting wire between them with a galvanic battery in its circuit. The galvanic battery generates the lines of force; these crowd together around it and push each other sideways until their ends are pushed down the wire and many of them are pushed out upon the balls.

When the tension backwards along the lines of force just balances the forward push of the electromotive force of the battery, equilibrium is established. If the wire is a good conductor, there may be electrical oscillations before the lines come to rest in a given position, and this I shall consider below.

The motion of the ends of the lines of force over and in the wire constitutes what is called an electric current in the wire which is accompanied by magnetic action around it and also by waves of electromagnetic disturbance which pass outward into space.

If, after equilibrium is established, we remove the wire, we have simply two charged spheres connected by lines of electrostatic force and thereby attracted to each other. If we replace the battery by a dynamo or by an electric machine the effect is the same.

But there is another way by which bodies are often charged and that is by *friction*. In this case we can suppose the glass to take hold of one end of the lines of force and the rubber the other end and it is then only necessary to pull the bodies asunder to fill the space with lines. The friction is merely needed to bring the two bodies into intimate contact and remove them gently from each other.

The following considerations may guide us in understanding the details of the process. It is well known from Faraday's researches that a given quantity of electricity has a fixed relation to the chemical equivalents of substances. Thus it requires 10,000 absolute electromagnetic units of electricity to deposit 114 grams of silver, 68 grams of copper, 34 grams of zinc, etc.

Hence we can consider, for instance, in chloride of silver that the atoms of silver are joined to the atoms of chlorine by lines of electrostatic force which hold them to each other. If, by rubbing the chloride of silver, we could remove the chlorine on the rubber while leaving the silver, we could stretch them asunder and so fill space with the lines of electrostatic force. According to this theory, then, each atom has a number of lines of force attached to it, and it is only by stretching the atoms apart that we can fill an appreciable space with them and so cause electrostatic action at a distance.

We come to the conclusion, then, that all electrification is originally produced by separating the atoms of bodies from one another, which can be done by breaking contact, by friction, or by direct chemical action of one substance on another, or in some other manner not so common. The lines of electrostatic force in a case of electricity at rest must always begin and end on matter, and they can never have their ends in space free from matter. The ends can be carried along with the matter, constituting electric convection, or they can slide through a metallic conductor or an electrolyte or rarefied gas, making what we call an electric current; but, as they cannot end in a vacuum, they cannot pass through it. Thus we conclude that a vacuum is a perfect non-conductor of electricity.

The exact process by which the ends of the lines of force pass through and along a conductor can at present be only dimly imagined, and no existing theory can be considered as entirely satisfactory. In the case of an electrolyte, however, we can form a fairly perfect picture ot what takes place as the decomposition goes on. Thus, in the case of zinc and copper in hydrochloric acid, we can imagine the zinc plate attracting the chlorine of the acid, thus stretching out the natural line of electric force connecting the chlorine atom and the first hydrogen atom; we can imagine the atoms of chlorine and hydrogen in the body of the liquid recombining with each other and their lines of force uniting until they form a complete line long enough to stretch from the zinc to the copper plate; and all without once making a line of force without its end upon matter. We can further imagine the ends of this line sliding along the copper and zinc plates to the conducting wires and down their length, thus making an electric current and carrying the energy of chemical action to a great distance.

If the ends of the lines should slide along the wire without any resistance, the wire would be a perfect conductor: but all substances present some resistance, and in this case heat is generated. This we always find where an electric current passes along a wire: as to the exact nature of this resistance or the nature of metallic conduction in general we know little, but I believe we are approaching the time when we can at least imagine what happens in this most interesting case.

Besides the heating due to the electric current, steadily flowing, we must now account for the magnetic lines of force surrounding the current and the magnetic induction of one current on the other.

If the current is produced by the ends of the tubes of electrostatic force moving along the wire, then we may imagine that the movement of the lines of electrostatic force in space produces the lines of magnetic force in a direction at right angles to the motion and to the direction of the lines of electrostatic force. At the same time we must be careful not to assume too readily that one is the cause and the other the effect: for we well know that a moving line of magnetic force (more properly induction) produces, as Faraday and Maxwell have shown, an electric force perpendicular to the magnetic line and to the direction of motion. Neither line can move without being accompanied by the other, and we can, for the moment, imagine either one as the cause of the other. However, for steady currents, it is simpler to take the moving lines of electrostatic force as the cause and the magnetic lines as the effect.

We have now to consider what happens when we have to deal with variable currents rather than steady ones.

In this case we know from the calculations of the great Maxwell and the demonstrations of Hertz that waves of electromagnetic disturbance are given out. To produce these waves, however, very violent disturbances are necessary. A fan waved gently in the air scarcely produces the mildest sort of waves, while a bee, with comparatively small wings moved quickly and vigorously, emits a loud sound.

So, with electricity, we must have a very violent electrical vibration before waves carrying much energy are given out.

Such a vibration we find when a spark passes from one conductor to another. The electrical system may be small in size, but the immensely rapid vibrations of millions of times per second, like the quick vibration of a bee's wing, sends out a volume of waves that a slowly moving current is not capable of producing. The velocity of these waves is now known to be very nearly 300,000 kilometers per second. This is exactly the velocity of waves of light, or other radiation in general, and there is no doubt at present in the minds of physicists that these waves of radiation are electromagnetic waves.

By this great discovery, which almost equals in importance that of gravitation, Maxwell has connected the theories of electricity and of light, and no theory of one can be complete without the other. Indeed they must both rest upon the properties of the same medium which fills all space—the ether.

Not only must this ether account for all ordinary electrical and magnetic actions, and for light and other radiation, but it must also account for the earth's magnetism and for gravitation.

To account for the earth's magnetism, we must suppose the ether to have such properties that the rotation of ordinary matter in it produces magnetism. To account for gravitation it must have such properties that two masses of matter in it tend to move toward each other with the known law of force, and without any loss of time in the action of the force. We know that moving electrical or magnetic bodies require a time represented by the velocity of light before they can attract each other in the line joining them. But, for gravitation, no time is allowable for the propagation of the attraction.

But the problem is not so hopeless as it at first appears. Have we not in two hundred and fifty years ascended from the idea of a viscous fluid surrounding the electrified body and protruding arms outward to draw in the light surrounding bodies to the grand idea of a universal medium which shall account for electricity, magnetism, light, and gravitation?

The theory of electricity and magnetism reduces itself, then, to the theory of the ether and its connection with ordinary matter, which we imagine to be always immersed in it. The ether is the medium by which alone one portion of matter can act upon another portion at a distance through apparently vacant space.

Let us then attempt to see in greater detail what the ether must explain in order that we may, if possible, imagine its nature.

1st. It must be able to explain electrostatic attraction. These electrostatic forces are mostly rather feeble as we ordinarily see them. Air breaks down and a spark passes when the tension on the ether amounts to about $\frac{1}{100}$ pound to the square inch. It is the air, however, that causes the break-down. Take the air entirely away, and we then know no limit to this force. In a suitable liquid it may amount to 500 times that in air or 5 pounds to 1 square inch, and become a very strong force indeed. In a perfect vacuum the limit is unknown, but it cannot be less than in a liquid, and may thus possibly amount to hundreds, if not thousands, of pounds to the square inch.

2d. It must explain magnetic action. These actions are apparently stronger than electrostatic actions, but in reality they are not necessarily so. A tension on the ether of only a few hundred pounds on the square inch will account for all magnetic attraction that we know of, although we are able to fix no limit to the force the ether will sustain. No signs have ever been discovered of the ether breaking down.

Again, we must be able to account for the magnetic rotation of polarized light as it passes through the magnetic field; and it can only be accounted for by assuming a rotation around the lines of magnetic force. This action, however, takes place only while the lines of magnetic force pass through matter, and it has never been observed in the ether itself. The velocity of rotation, however, is immense, the plane of polarization rotating in some cases 300,000,000 times per second.

The ether must also account for the earth's magnetism. If we assume that magnetic lines of force are simply vortex filaments in the ether, we have only to suppose that the ether is carried around by the rotation of the earth, and we have the explanation needed. The magnetism of the earth would then be simply a whirlpool in the ether.

3d. The ether must be able to transmit to a distance an immense amount of energy either by means of electromagnetic waves as in light or by the similar action which takes place in the ether surrounding a wire carrying an electric current.

The amount of energy which can be transmitted by the ether in this manner is enormous, far exceeding that which can be carried by anything composed of ordinary matter. Thus take the case of sunlight: on the earth's surface illuminated by strong sunlight a horse-power of energy falls on every 7 square feet. At the surface of the sun the etherial waves carry energy outward at the rate of nearly 8000 horse-power per square foot!

Again, an electric wire as large as a knitting needle, surrounded with a tube half an inch in diameter in which a perfect vacuum has been made to prevent the escape of electricity, may convey to a distance a thousand horse-power, indeed even ten thousand or more horse-power, there being apparently no limit to the amount the ether can carry.

Compare this with the steam-engine, where only a few hundred horse-power require an enormous and clumsy steam pipe. Or, again, the amount carried by a steel shaft, which, at ordinary rate of speed, would require to be about a foot in diameter to transmit 10,000 horse-power.

When we compare the energy transmitted through a square foot of ether in waves, as in the case of the sun, with the amount that can be conveyed by means of sound waves in air or even sound waves in steel, the comparison becomes simply ridiculous, the ether being so immensely superior. As quick as light, the ether sends its wave energy to the distance of a million miles while the sluggard air carries it one. Thus, with equal strain on each, the ether carries away a million times the energy that the air could do.

4th. The ether must account for gravitation. For this purpose we are allowed no time whatever to transmit the attraction. As soon as the position of two bodies is altered, just so soon must the line of action from one to the other be in the straight line between them.

If this were not so, the motion of the planets around the sun would be greatly altered. Toward the invention of such an ether, capable of carrying on all these actions at once, the minds of many scientific men are bent. Now and then we are able to give the ether such properties as to explain one or two of the phenomena, but we always come into conflict with other phenomena that equally demand explanation.

There is one trouble about the ether which is rather difficult to explain, and that is the fact that it does not seem to concentrate itself about the heavenly bodies. As far as we are able to test the point, light passes in a straight line through space even when near one of the larger planets, unless the latter possesses an atmosphere. This could hardly happen unless the ether was entirely incompressible or else possessed no weight.

If the ether is the *cause* of gravitation, however, it is placed outside the category of ordinary matter, and it may thus have no weight although still having inertia,—a thing impossible for ordinary matter where the weight is always exactly proportional to inertia.

Ether, then, is not matter, but something on which many of the properties of matter depend.

It is curious to note that Newton conceived of a theory of gravitation based on the ether, which he supposed to be more rare around ordinary matter than in free space. But the above considerations would cause the rejection of such a theory. We have absolutely no adequate theory of gravitation as produced by the ether.

To explain magnetism, physicists usually look to some rotation in the ether. The magnetic rotation of the plane of polarization of light together with the fact of the mere rotation of ordinary matter, as exemplified by the earth's magnetism, both point to rotation in the ether as the cause of magnetism. A smoke ring gives, to some extent, the modern idea of a magnetic line of force. It is a vortex filament in the ether.

Electrostatic action is more difficult to explain, and we have hardly got further than the vague idea that it is due to some sort of elastic yielding in the ether.

Light and radiation in general are explained when we understand clearly magnetic and electrostatic actions as the two are linked together with certainty by Maxwell's theory.

Where is the genius who will give us an ether that will reconcile all these phenomena with one another and show that they all come from the properties of one simple fluid filling all space, the life-blood of the universe—the ether?

THE DRAINAGE SYSTEM OF THE VALLEY OF MEXICO.

By Señor Don Matias Romero,

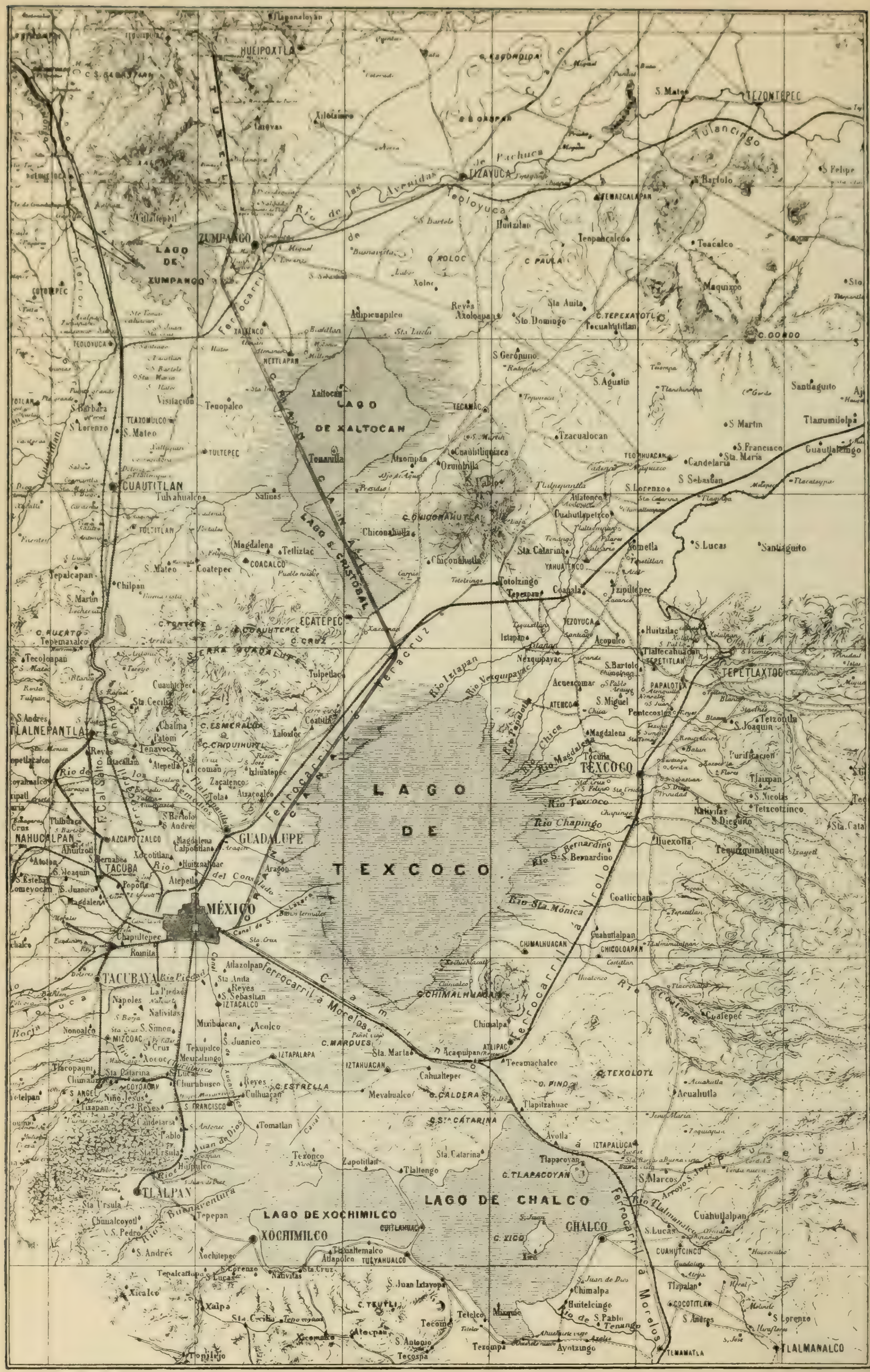
The Mexican Minister at Washington.

MEXICO is about finishing a great work, the drainage of the Mexican valley, which has required for its completion nearly three hundred years and many millions of dollars, and has cost the lives of hundreds of thousands of men. The necessity, importance, and magnitude of this work, which will be classed among the grandest achievements of men, and the nearness of its completion, induce me to write this paper, which I hope will give some idea of its scope and purpose. I do not pretend to originality, as my work to some extent has been one of compilation from different monographs, which have appeared from time to time, and from some official publications of the Mexican government. I am indebted, also, to Mr. Farmer P. Gaston, and others for assistance.

The Valley of Mexico is an immense basin, of approximately circular shape with one extreme diameter of about sixty miles, completely bounded by high mountains, and having only two or three quite high passes out of it. No water drains out of the basin. The surface of this valley has a mean altitude above the sea of 7413 feet, and an area of about 2220 square miles.

Mountain ranges rise on every side, making a great corral of rock containing dozens of villages and hamlets with the ancient capital in the center. In times past the fires of volcanoes licked up the earth, and such fires still live in the mammoth Popocatapetl, from whose great maw sulphur fumes and smoke with jets of flame have poured through the centuries.

The valley thus hemmed in with solid walls of rock had been an inland sea for many cycles, and during the early existence of man here the salt waters spread over a large extent of the depression. The waters have been gradually lessening by seepage and evaporation, and the Aztec pilgrims coming from the north in the fourteenth century, having received a sign that they were to build their queen-of-the-world city on a small island of the sea, set about building dikes and combating the overflow of the waters. Many of their works remain to this day, and show that the valley was divided by them into five great departments. The dikes were built under the direction of King



HYDROGRAPHIC CHART OF THE VALLEY OF MEXICO—LOCATION OF THE DRAINAGE CANAL.

Netzahualcoyotl, a relative of the Emperor Moctezuma, whose surviving works prove him to have been an engineer whose conceptions and accomplishments would have given him high standing even among modern engineers.

One of the immense dikes he built was ten miles long. It divided Lake Texcoco into two parts. Of the two lakes thus formed one was allowed to remain salt, but the other was freshened by allowing only fresh water to enter by the streams flowing in, the water for the use of the city being taken from this latter. Little by little the waters have subsided since that period, and have been fought back, until now they are confined to six great lakes—Chalco, Xochimilco, Texcoco, Xaltocan, San Cristobal, and Zumpango. Each of these lakes is fed by streams which have little volume during the dry season, but which in the rainy season swell to considerable size, and at times overflow the valleys. The Lake of Zumpango was the most dangerous of these, for it received the waters of the Cuautitlan river,—a river draining a large area of country, and having during the rainy season a large volume of water. This river has been turned into the cut of Nochixtongo, and has ceased to threaten Mexico and its environs with its overflow.

From these topographical conditions frequent floodings of the old Aztec city end of the Spanish capital, situated almost at the lowest point of the valley, were sure to come in times of unusually heavy rains. In early days, when the Aztecs lived in the middle of Lake Mexico, when their temples and wigwams were built on piles and the streets were often only canals, the periodical overflows from the upper lakes were a matter of small concern, though even then the Nahua engineers were called upon to protect the city by dikes. But when by evaporation, by filling in at the site of the city, by lessened waters, due to the fissures caused by earthquakes, Lake Mexico had disappeared, and the city had come to be built on the spongy soil ; above all, when the short-sighted choice of Cortez had been confirmed and the capital of New-Spain had come to stand on the ruins of the Aztec town, increasing rapidly in population and wealth,—it became a serious matter that on an average of once in twenty-five years the streets should be from two to six feet under water for an indefinite time.

Several times in the past, and centuries since the establishment of the city, the waters have been forced above their banks by freshets and floods from the hills ; and although such events were not frequent, they nevertheless taught the dwellers in the town that in the waters lurked a constant menace to life and property. During the last great inundation in the seventeenth century the water stood at the level of the second story of the houses in the City of Mexico for several years, and even now the water marks of the flood which made the place into a western Venice are to be discerned. The removal of this danger from floods has been in the past a question of constant perplexity and debate.

Various attempts were made to remedy this condition of things, but nothing effective was accomplished until the early part of the seventeenth century, when plans were prepared for the building of a canal from Lake Zumpango to the foot of the mountains at Huehuetoca, thence a tunnel through the ridge over a league in length and nearly 15 feet wide by 12 in height, leading into a cut whence the river Tula was reached.

The cut of Nochixtongo was the result of this plan of tunneling for an escape of the waters, proposed by Enrico Martinez, a humble printer, early in the seventeenth century. After much indifference and delay his plan was finally approved in part, and he was put in charge of the work ; but he was sadly hampered by opposition and the changes made from his original design. Work on the tunnel of ten miles' length was commenced in November, 1607, and by working 15,000 Indians the task was completed in the almost incredible space of eleven months. Spain, engaged in armed debates with European enemies at this time, left no funds in Mexico for prosecuting public works. The tunnel was therefore completed with the least possible cost, and instead of being lined with masonry it was merely timbered after the fashion of "lagging" in a mine. On the waters from Zumpango, the highest lake, being turned through it, serious cavings in of the top and sides of the earthen exit very naturally resulted.

The problem was only partially and unsatisfactorily solved by this tunnel. In 1627 heavy rains caused the Cuautitlan to overflow into the lower lakes, and Mexico was left under eighteen inches of water. In 1629 the city was six feet under water, and remained so practically for four years. The question of moving the city to higher ground was then seriously considered. Fortunately, in 1634, an earthquake rent the valley and drew off the water, so that it was possible to fall back on the former plan of mending dikes and repairing the tunnel.

The tunnel was blocked up by this cause, and Martinez was cruelly scored for not having done his work aright by the very ones who had refused to give him the necessary material for it. He bravely essayed to repair the damage, but the water-soaked condition of the ground gave no resistance for the building of the needed walls, while death mowed down the enslaved workers. They were crushed to death by the frequent cavings in of the loose soil, or were sent to the grave by the deadly damps. Finally, the charge being made that the builder was blocking up the tunnel in revenge, he was thrown into prison, where he languished for many months. As there was no one else available who could carry on the great work, he was afterwards released and again put in charge. It was then decided that, the tunnel being completely useless, the next thing to be done would be to make a great cut down to the tunnel and thus open it out. This entailed the making of an excavation fourteen miles in length with an average depth of 180 feet and width of 400 feet.

Martinez struggled on with this work for 37 years, and then died an unhonored death. All trace of his place of final rest was lost. The Spaniards continued the work in other hands for 150 years before the task of opening the cut was completed. Spasmodic work for a century and a half led at last to the accomplishment of this project in 1789. The old tunnel of Martinez is now a gigantic trench from 30 to 160 feet in depth and 300 feet broad in some places, and is known as the Tajo de Nochixtongo. The immediate vicinity of the workings was depopulated of its native inhabitants by the insatiable demands of the killing labor, and recruits were then drawn from Puebla and other thickly populated Indian centers. Great prison barracks were built on the bare hills, and here all the criminals were sent to enter the work. The ones in charge were indifferent with regard to the lives entrusted to their care, and the slaughter, of which scant record remains in the parish burial books, and which resulted from a combination of defects in appliances for both the safety and the comfort of the workmen, was terrific. As the burial trenches were filled with new dead, the depths of the cut were tenanted by new laborers.

The victims of three years of bondage numbered fully 200,000 ere the work was done. Yet the results were but slight, only the excess of water from the highest lakes and streams being carried off. However, the danger from inundation of the city has been very materially decreased by the Nochixtongo opening, and no more deluges have occurred since its completion.

Still the fact that the bottom of the cut was thirty feet higher than the surface of Texcoco, the lowest lying of the lakes, left the city in danger of inundation, as Lake Texcoco is constantly filling up at the rate of one and one-half inches a year and is now but a few feet below the level of the main plaza of the city.

The drainage works had long been a heavy burden upon the Mexican treasury. Up to 1637 Bancroft estimates that $3,000,000 had been expended. Up to the year 1800 the outlay had reached $6,247,670. Up to 1830 the total expenditure was $8,000,000.

The problem faced to-day by the Mexican government is very different from that which confronted Martinez in 1607. The question of preventing submergence is practically solved. The work of Martinez, unsatisfactory as it was, did a great deal to solve it. Since his day the area of the lakes has been gradually diminishing. The rapid evaporation in the rarefied air and under the direct sun of the valley partly accounts for this. Twice the water in Lake Texcoco has almost entirely disappeared, leaving only a sea of mud and a small pool. The great problem which the Mexican government is now trying to solve is not how to prevent an inflow of water, but how to provide an outlet for sewerage. The danger now to be averted is not that of drowning, but that of dying from the plague.

Lake Texcoco more than any other now menaces the security of the capital. The unwise cutting down of forests since the Spanish conquest permits the waters pouring down into the valley to bring with them annually great quantities of alluvial matter, which have so much raised the lake bottom and the water level that inundations have been of frequent occurrence. The general level of the City of Mexico is only 6.56 feet above the surface of the lake. The rainy season lasts from June to October inclusive. During this season five times as much water falls as during the rest of the year, evaporation can no longer compensate for rainfall, and the valley is more or less flooded.

Originally built in the midst of a lake, the city has been left on dry ground by the receding waters. Lake Texcoco,—some three miles distant,—Chalco, and Xochimilco have altitudes nearly four feet greater than the pavement of the capital. Still more imperiously do the lakes to the north dominate the city. San Cristobal and Xaltocan are about five feet, while Zumpango is over thirteen feet, above it.

The project now almost completed is a modification of a scheme projected by Simon Mendez in the time of the Spanish government, and which in 1849 was adopted by Captain Smith of the corps of American engineers which accompanied General Scott's army. The tunnel was ultimately located under the saddle and through the ravine of Acatlan, its mouth being near the village of Tequixquiac. The works have been begun several times, and then suspended without effecting anything of importance. In 1866 the works now nearing completion were commenced. A project proposed by Señor Francisco de Garay, a well-known engineer of the City of Mexico, was pronounced the most feasible. But the revolutionary struggle succeeded, and for many years the work was relegated to the background.

In 1879 engineer Don Luis Espinosa, the present director of the works, took charge of the undertaking. In the first period mentioned the cutting of Tequixquiac was excavated, and the greater part of the shafts were begun ; but at that point the work was stopped by political agitations. The work was really commenced in 1885, when the city council of Mexico submitted a project to the federal government, and offered to contribute largely to the cost.

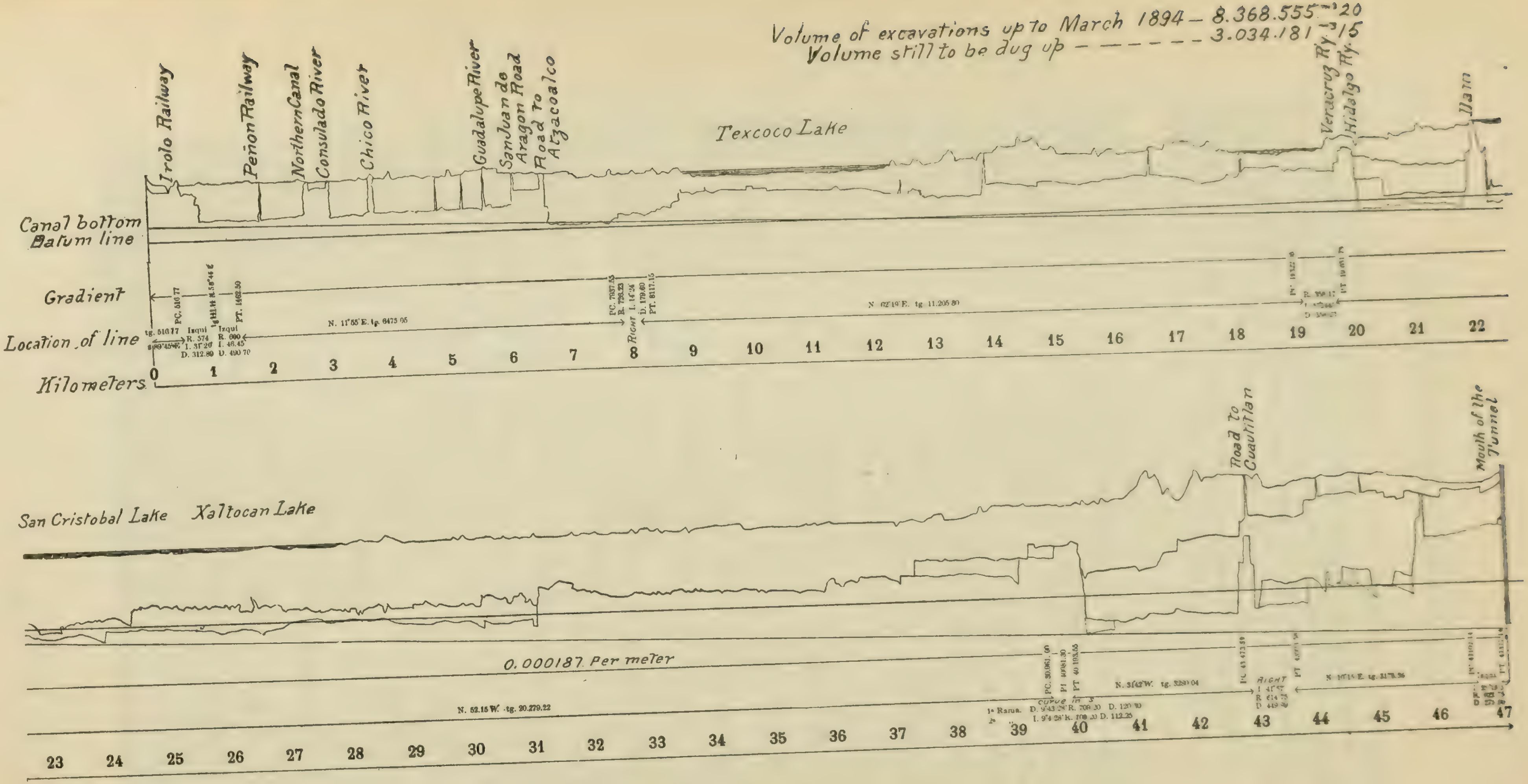
President Porfirio Diaz then named a special commission with ample authority to disburse the funds dedicated to the work, and this body up to the present date has directed its execution. The sum of $400,000 per annum was placed at the disposal of the commission by the city council, and this amount was increased by the government to a sufficient sum. Two years later the city council contracted a loan in London of £2,400,000, the proceeds of which have served to meet the current cost of the work and to guarantee its successful issue.

The city council was able to assume the entire responsibility of the work, as the federal government ceded to it a part of the taxes to be collected, and authorized it to collect new taxes. Having expended the proceeds of the £2,400,000 loan without finishing the work, the Mexican government applied to its completion a portion of another federal loan of £3,000,000 recently negotiated in London.

The drainage works, when carried out, will receive the surplus waters and sewage of the City of Mexico and carry them outside of the valley, and will also control the entire waters of the valley, affording an outlet, whenever found necessary, to those which might otherwise overflow fields and towns, rendering the soil stagnant and marshy. The work consists of three parts—a canal starting from the gate of San Lazaro and having a length of 47.580 kilometers, its line following on the eastern side of the Guadalupe range of hills and between that range and Lake Texcoco, changing its direction after arriving at the 20th kilometer to a northeasterly direction, so as to diagonally cross Lake San Cristobal, a part of Lake Xaltocan, and a part of Lake Zumpango, and arriving finally at the mouth of the tunnel near the town of Zumpango.

The level of the bottom of the canal above the datum line adopted is 2.25 m. and the mouth of the tunnel is 9.20 m. below the same datum, supposed to pass 10 meters below the bottom of the Aztec calander stone. The level of the ground at the beginning of the canal is 8.94 m., and at the end 15.86 m., above datum. The uniform slope of the canal is at the rate of 0.187 per kilometer.

The canal has a depth, at its commencement, of 5.50 m., which in the last few kilometers is increased to 20.50 m. The side slopes were projected with a batter of 45 degrees, and the width of the bottom is 5.50 m. for the first 20 kilometers, and 6.50 in the rest of the canal. Referring to the map, the first 20 kilometers may be considered as a prolongation of the net of sewers in the city, and will receive only the water that passes through them. The flow is calculated for an average of 5 cubic meters, although, when heavy rains require it, they can receive a greater volume; the rest of the canal communicates with Lake Texcoco, and will be utilized in controlling its waters,—the low-



SCALE
Horizontal........$\frac{1}{50.000}$
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DRAINAGE OF THE VALLEY OF MEXICO LONGITUDINAL SECTION OF THE MAIN CANAL

est in the valley,—which can be made to flow into the canal from all parts. Hence the canal has been built to carry the largest flow that can pass through the tunnel, or 18 cubic meters per second. The cutting is through a strictly clay formation, comprising occasional thin strata of sand and sandstone.

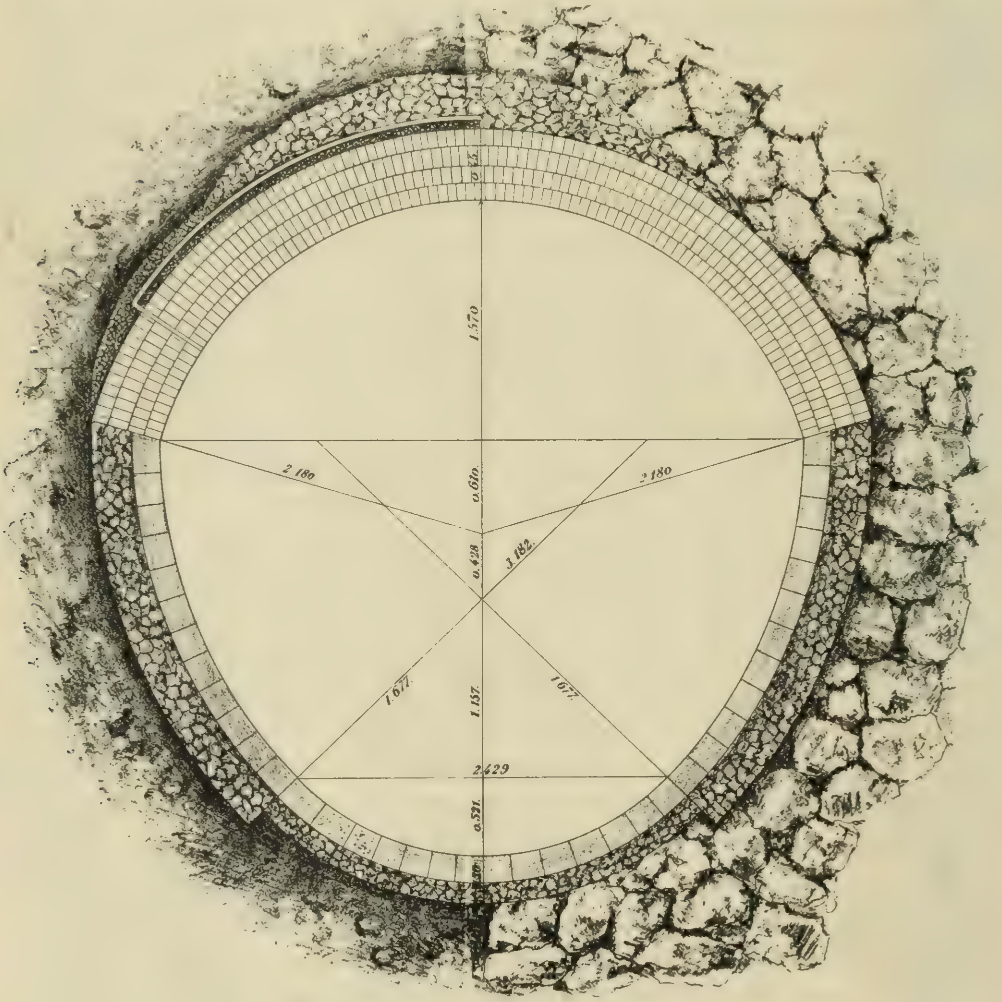
For accommodation of railroads, wagon roads, and water courses it will be necessary to construct five aqueducts—four of masonry and one of iron—to carry rivers, four iron bridges for the passage of railroads, and 14 bridges for other roads.

The sewers of the City of Mexico form a network of covered channels, located sometimes in the middle and sometimes on the sides of the streets, these being almost always gorges, communicating with a system of secondary sewers that empty into a collecting sewer discharging into the canal of San Lazaro, which transports the sewage to Lake Texcoco. If the water is high in the lake, water backs up into the sewers and saturates the soil under the houses and streets. As this has been the condition for several centuries, the state of the subsoil under the city can be better imagined than described. The death-rate touches 40 per 1000,—the highest in the civilized world. Mexico's elevation of over 7000 feet is all that saves it from a pestilence. Malarial and gastric fevers are almost continually epidemic.

For a century the problem has been settling into one of pure sanitation. The plans which the government has been working since about 1883, though called plans for draining the valley, really seek to get a fall sufficient to dispose of the sewage. In fact, in the original plan, from considerations of economy, care was to be taken to keep out of the projected canal all water both from the surface of the valley and from the rivers. The Consulado and the Guadalupe rivers were to be carried over the new canal in iron aqueducts. The drainage system was thus to be simply a part of the sewerage system of the city.

The excavated materials have been tipped on each side of the canal at their natural slopes, and a towpath near the canal level provided. Sluice gates will direct the city drainage either to the canal or to Lake Texcoco. A sluice gate at the junction of the smaller with the larger part of the canal will control the flow of Lake Texcoco, and another sluice will be placed at the entrance of the tunnel.

The tunnel has a length of 10,021.79 m., with a curved section formed by four curves respectively of the following dimensions. The upper part will have a span of 4.185 m. and a rise of 1.570 m.; the two lateral arches will have a chord each of 2.36 m., a radius with a chord of 2.429 m., and a rise of 0.521 m.; the elevation will be 4.286 m.; and the greatest width will be the span of the upper arch: the accompanying drawings show this section. The tunnel is lined with brick, having a thickness in the upper part of 0.45 m., and in the lower part, over which the water will run, of 0.40 m. in the side arches and of 0.30 in the radius, this latter lining being of artificial stone, made of sand and Portland cement. The elevation of the invert at the beginning of the tunnel will be 9.20 m. below datum; at the end of the tunnel, 17.53 below datum. The gradient will be 0.00069 per meter for the first 2170.74 m., 0.00072 for the following 5831 m., 0.001 for 5100 m., and 0.00135 for the rest of the tunnel, these changes being in accordance with changes of details made from those of the original project, in some cases modifying the section and in other cases the lining. Twenty-five shafts each 2 × 3 meters were opened at a distance of 400 m. from each other. These served to ventilate the tunnel and to push the work. The deepest of these shafts, situated on the saddle of Acatlan, has a depth of 92 m.; the shallowest is 21 m. To give an idea of the labor involved beyond



SECTION OF THE TUNNEL.

the mere tunneling, I may mention that the quantity of materials required per lineal yard of tunnel was 1800 bricks, 94 cement blocks, 3 cubic yards of mortar, and 70 cubic feet of volcanic stone.

In May, 1894, the department of public works of Mexico contracted with Messrs. S. Pearson and Son of London for the completion of the canal, modifying former contracts of December 25, 1889, March 30, 1891, and April 18, 1893, under the following bases. The unfinished excavation in the first nine kilometers, and that between kilometer 47 and the entrance of the tunnel of Tequixquiac, are to be continued by the board of drainage directors, who must have the latter portion completed to 10 meters below the surface of the soil by December 31, 1894, and to the required depth of the canal by May 31, 1895, in order that the water in the canal may settle to that level and permit the contractors to slope the walls as required by the contract. The contractors are to complete the canal between kilometers 9 and 47 for the sum of $3,506,000. For making the monthly estimates the canal will be divided into two sections—kilometers 9 to 22 and kilometers 22 to 47. In the first section the provisional estimate will be 40 cents per cubic meter; in the second, a sum equal to the quotient obtained by dividing the remainder of the money by the number of cubic meters to be removed. The contractors may suspend the work of the dredges when they fall below 40 cubic meters per hour, and can proceed with the excavation in any way they wish. The excavation must be completed by May 1, 1896, except in the parts where the dredges cannot work. Then for each day's delay the contractors must pay $500 fine, and after five months the contract will be rescinded.

When the drainage board took charge of the work, it was executed by day labor both in the canal and in the tunnel, the latter having the larger amounts expended on it. But, shortly afterwards, the contract for the tunnel was let to Messrs. Read and Campbell, of London, who, after having invested a considerable sum in the work, found themselves under the necessity of cancelling their contract at the beginning of the year 1892. These gentlemen have continued to handle the work, but as managers, and under the direction of the board.

The excavation of the grand canal was originally contracted for by the Bucyrus Company of the United States, of which Colonel Harris, of Cleveland, was the president. This company brought two spoon dredges, capable of extracting up to 1000 cubic meters per day, and with these it commenced its excavations at the 22d kilometer. After the lapse of a few months, the board commissioners, desiring to push the work of excavation as much as possible, cancelled the contract with this company, and executed the one at present in force with the English contracting firm of Messrs. S. Pearson and Son, who have undertaken to complete the canal by the month of September, 1895. These contractors are carrying out the work of the canal in two different ways,—by hand work with centrifugal pumps to draw off the water which filters into the work, and by means of enormously powerful Couloir dredgers which have a capacity for 3000 cubic meters of excavation per day, and which throw the excavated earth to a distance of more than 200 meters from the center of the canal. They have at present five of these dredgers at work, and by means of them can excavate to a depth of twenty meters, raising the earth to an elevation of more than 16 meters, so as to empty it into the shoots, along which it is carried by a stream of water that delivers it at a considerable distance from the dredger.

Sixteen months will see the opening of the great water way for the escape of the imprisoned floods of the valley, which in centuries past have been a constant menace to the city and its safety. The canal and six-mile tunnel through the mountain range have a total length approaching forty miles. The present works, when completed, will take rank with the great achievements of modern times, just as the immense "cut" of Nochixtongo, their unsuccessful predecessor, was the leader among ancient earthworks in all the world. The new tunnel is now complete, and light is shining from one end of it to the other. The completed system will have cost $20,000,000.

I have dealt with these works at some length, because their importance to the City of Mexico can hardly be overestimated. Instead of being one of the healthiest cities in the world, as it should be with its magnificent climate and situation, Mexico unfortunately has a terribly heavy death-rate, due principally to want of drainage and generally bad sanitary condition. When the existing danger of floods is removed, and the sanitary evils are remedied by a proper system of drainage, the increased security that will be enjoyed by life and property will certainly have its effect on the prosperity of the city. Property will rise in value, the population will grow with rapidity, not to mention the tide of tourists that will set in from the United States, and this will mean larger revenues for the municipality.

I could not well finish this paper without paying General Diaz, President of Mexico, a just tribute for the great interest he has taken in having this great work brought to a close during his administration. To his exertions in this regard and to his commanding position in Mexico, more than to anything else, this happy result, now almost in sight, is due. So after a weary search of centuries for relief, the beautiful valley of Mexico will gain its deliverance not only from the engulfing floods, but from the sanitary evils which have long resulted from defective drainage.

THE ARCHITECTURE OF MUNICIPAL BUILDINGS.

By E. C. Gardner.

MARLEY was dead to begin with. It is equally certain that our municipal architecture is bad,—which is about the same thing. In the case of Marley nobody but Scrooge cared to ask in what way he died, or why, or if he could be brought back to life. In the case of our architecture it is extremely desirable to discover in what its badness consists, why it has become bad, and then, if a reasonable solution of these questions can be found, to inquire still further how it can be restored to life and usefulness.

To plunge at once into the midst of things, no municipal building can claim architectural excellence which is not perfectly adapted to its site, to its use, to the number and dignity of the people who build it, to the length of time it is expected to exist, and to the influence it ought to exert upon the community in which it stands. Obviously a building suitable for a level plain will not be exactly fitted to crown a hill. It would be inexcusable to allow a school-house to present such an outward appearance that it might be mistaken for a jail, a factory, or a stable ; or to give a distinctly ecclesiastical air to a city hall with its large family of most unecclesiastical civic offices ; and what would be appropriate for a city of half a million inhabitants would be absurdly disproportioned to one of fifty thousand. To make false use of materials, to introduce frauds and cheap imitations, to temporize for the sake of saving to-day what will cost double to-morrow, to construct public buildings that, as long as they endure, will proclaim to friends and foes, to citizens and strangers, the vanity, parsimony, or ignorance of the people who build them,—all these things ought to be easily understood and avoided. And yet it would be difficult to find a city from Maine to California in which many of these architectural crimes have not been committed, and committed recently. In the past, poverty may have been urged as an excuse for some of them. But the most grievous faults are not the result of poverty. In fact, that stern master is sometimes as beneficent in its effect on municipal architecture as it is in the formation of human character,—preventing the growth and display of coarse and disastrous inclinations. There was also an excusable ignorance, the results of which may be winked at. But neither poverty nor ignorance can now be accepted in extenuation when a city allows a badly designed, badly planned, badly constructed public edifice to disgrace its citizens. For it must not be forgotten that with our form of government every man, in proportion to his intelligence and activity, is responsible for all public achievements, including mistakes and failures in building.

Concerning the site for public buildings a fatal, because incurable, mistake is often made in their location, and more frequently still in the small amount of land appropriated. Leaving esthetic and sentimental considerations aside, it is simply common sense to say that for all usual municipal buildings the lot on which each one stands should be at least large enough to allow adequate natural lighting of the interior, whatever the height of the adjacent buildings may be; to afford ample and direct entrances to and exits from different parts of the building; and to preclude all annoyance from the ordinary use of the nearest streets. Fire-engine houses might be an exception to this rule, while for schoolhouses it would often be inadequate. Undoubtedly the city hall, which is, par excellence, *the* municipal building, should be as near the center of the city as possible; and, as land there is sure to be the most valuable, the tendency to keep the lot within narrow limits is inevitable. There are few cities that are not suffering from this mistaken economy on the part of the citizens, this want of courage and good judgment on the part of the city government.

The wise builders of the middle ages, and of the ages called "dark," liked to give their municipal halls room enough not merely for use, but for the display of their beauty of form and proportion. They seemed to understand better than we do that there is no architectural folly greater than placing a noble building where its wealth of beauty will be forever dimmed, if not wholly lost. It is surely a strange thing with our unlimited territory where every city (except New York) has a chance to grow and occupy all the room it pleases, if we cannot spare as much land for our municipal buildings as the closely built—and often walled—cities of the old world.

In large cities where space is exceedingly valuable the character of the ground is of comparatively small importance, except that the expense of making a solid bed of a treacherous bog or a bottomless quicksand must be added to the cost of the land. This is not the place to enter into the details of safe foundations, but it may be said that it would be difficult to find a piece of ground on which by the aid of engineering skill the heaviest kind of structure may not be placed in absolute security and permanence. (This point of fitness to its site is, so to speak, double-faced: before the building can suit the site, the site must be appropriate for the building.)

Adaptation to use includes, of course, the construction of the building, the arrangement of the floor plans, and the architectural expression, or style, of the exterior; and while these things would seem to need no argument, it is apparent that all three of them are oftener determined by tradition and the influence of bad examples than by intelligent radical study of actual needs. Some prevailing fashion, some fancied requirements of "effect" either within or without, some useless but long-established mannerism leads to the continuation of faults that never had any excuse for existence. It would seem, for instance, to go without saying that school buildings in which from one hundred to a thousand children assemble once or twice a day, where they spend from one-third to one-half of their waking hours, should be arranged solely for their health, comfort, security, and enjoyment; that anything about the building which does not tend directly and openly to these ends is not only useless but offensive; likewise that the appearance of such buildings should to the greatest possible extent proclaim their motive and declare the dignity of their mission. And yet with all our professed love for free schools, and conviction that public education is the corner stone of our social and civil institutions,—in fact, of the nation itself,—there is often a vast inconsistency between our profession and our practice. Poorly lighted, badly ventilated, inconveniently arranged school-houses have been the rule rather than the exception until within a very few years. We have not been averse to making a cheap display of liberality, but the ruling passion to "reduce the taxes" not infrequently brings forth school-houses that suggest a cross between a cotton factory and

Town Hall, Middleburg, Holland.

Town Hall, Oudenarde, Belgium.

Town Hall, Siena, Italy.

CITY HALL, LEEDS.

a house of correction.

The only claim of fitness to their use in such buildings must be based on the notion that a public school is a place where learning is manufactured like beer in a brewery, while the passive recipients thereof are forcibly detained in order to receive their bitter discipline.

The city halls in which the audience of five hundred or five thousand, as the case may be, can see and hear in safety, in which the ventilation is not distinctly bad, in which the entrances and exits are safe, easy, and ample, in which the various offices are well lighted and conveniently arranged for the expeditious transaction of public business, and which are placed on large lots of land in the most convenient and suitable part of the city, are also few and far between.

HIGH SCHOOL, EDINBURGH.

A public building should be characteristic of the people who build it. Happily in this great republic of ours there are no such differences in rank or character that a type of building really appropriate for one city would be distinctly inappropriate for another of similar size, though there are minor differences that may well claim recognition. We have univer-

MANSION HOUSE, LONDON.

CITY HALL, PARIS.

CITY HALL, HAVRE.

CITY HALL, ANTWERP, BELGIUM.

PALACE OF THE PODESTA, BOLOGNA, ITALY.

sity towns, capitals of States, manufacturing and commercial cities, and those whose environment and interests are chiefly agricultural, as well as the great cities which are cosmopolitan in character. What is most perfectly adapted to one of these would not be equally suitable for either of the others.

Suitability to the length of time a building is intended to exist involves at once the question of materials. Not referring to the visible surfaces of the outer walls, there are but two, iron and clay ; iron including steel, and clay including all kinds of bricks, tiles, terra-cotta, and cement. At the present time these are the only materials suitable for the essential structure of any building intended to endure a century or more. Under right conditions, both are indestructible by time and fire, and no one need be ignorant that the difference in cost between a building that cannot be burned and one that will dissolve in flames like frost before the rising sun is so slight that it would be no extravagance for the most impecunious cities to require all public buildings to be fireproof.

"Fire-proofing" the dangerous places, "slow burning" construction, and automatic sprinkling are well as far as they go ; but guarding the dangerous places only drives the danger somewhere else, slow burning construction, like the traditional green wood, makes the hot-test fire, when it does burn, and automatic sprinkling is liable to exercise its automatic instinct at the wrong time, so that after all there is nothing like using materials that neither time nor fire will destroy.

Surely a public building that can be destroyed in a night by conflagration lacks in a fatal degree the essential quality of fitness for long life.

Notwithstanding the rapid increase in the use of terra-cotta and the generally accepted recognition of its merits, it must be said that the modern product of our manufactures is an experiment to the extent that it has not yet withstood the test of time There are examples of terra-cotta hundreds if not thousands of years old that are apparently as perfect now as when made, but they were made in the good old times of honesty, not in the modern days of skill,—in adulteration,—and time still remains the only infallible test of the material. Yet there is such an overwhelming belief in its merits, it lends itself so readily to any desired effects of form and color, and is, withal, so moderate in cost, that it is impossible to avoid accepting it—risking it, if you please—as one of the most satisfactory of building materials.

The briefest reference to the building stones suitable for exterior walls would make a long article ; and, though local pride may suggest that the home product should be used, if there is one, there may also be a national pride in our wonderful facilities for transportation, which make it possible to use whatever seems most desirable without incur-

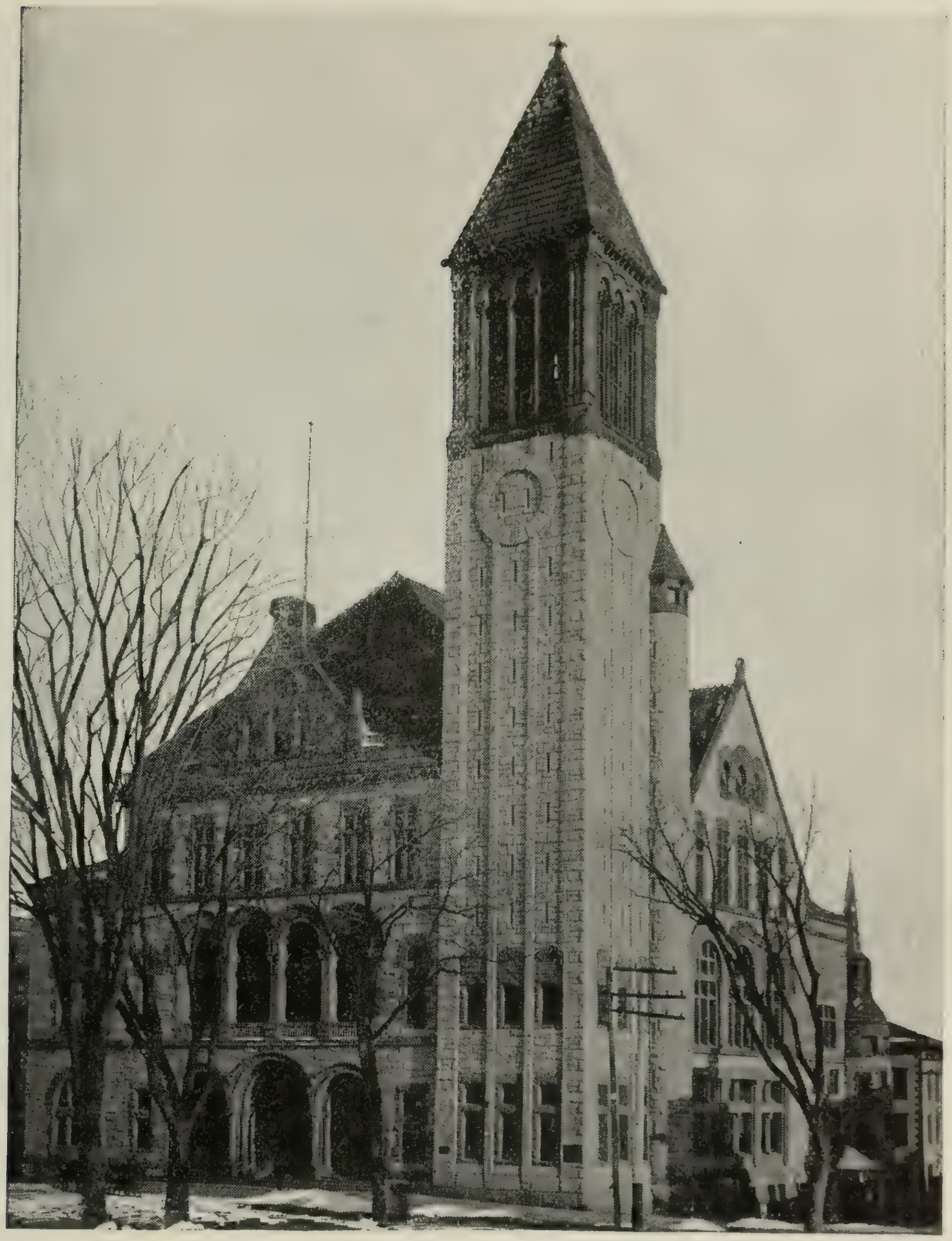
PALACE OF THE COUNCIL, VERONA, ITALY.

CITY HALL, NEW YORK.

ring the charge of extravagance. One thing seems apparent: in many parts of the country we have become so accustomed to dark red bricks and darker brown-stone that we scarcely realize their somber effect.

When, in the consideration of this same quality, we reach the question of the influence on the community in which it stands, we enter upon sentimental and esthetic ground; but there is also a practical side. Improved methods of building as regards construction, utility, and economy are desirable; and, from the purely commercial point of view, it would be a wise investment for every city to erect at the public expense and as often as every two years some useful building which should be an object lesson illustrating the best methods of building. It is hardly necessary to refer to the fact that the municipal buildings of many cities, large and small, are amazingly impressive lessons of "how not to do it," stern teachers of things to be avoided in the matter of materials and workmanship, and in the business methods by which the work is executed.

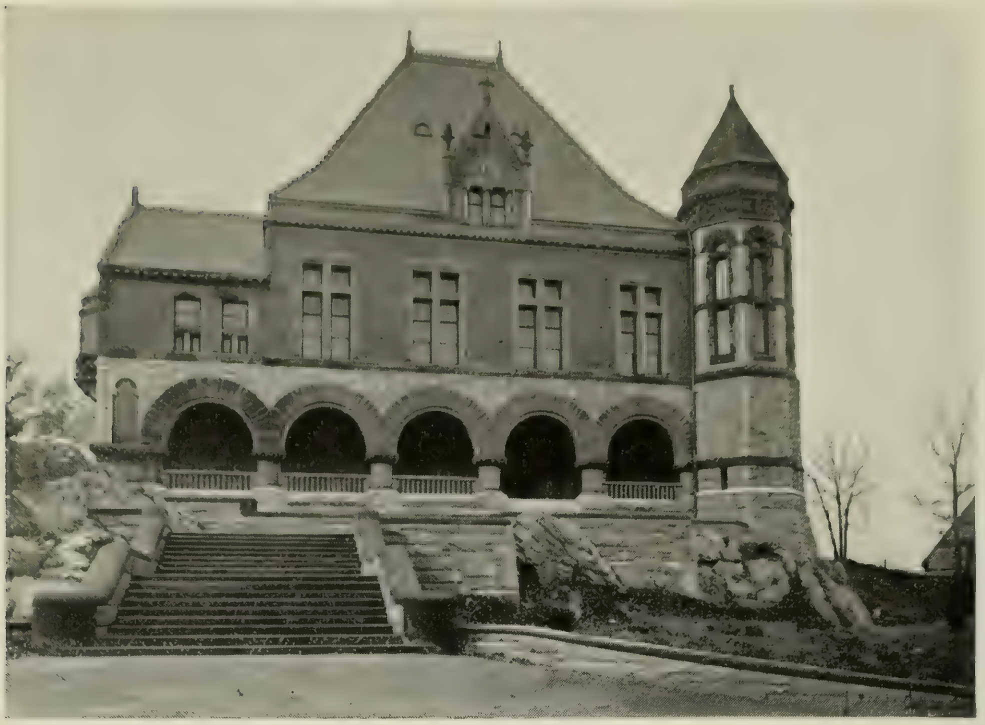
It is a sign of cowardice or indolence to throw away everything that is tempting to thieves in order to avoid being plundered, and there is no more mistaken notion than that the liberal use of public



CITY HALL, ALBANY, N. Y.

funds is necessarily wasteful and must always be prevented. Stealing must be prevented, so must frauds and collusion with dishonest contractors and with architects who, by illicit commissions from dealers in materials or by special "arrangements" with contractors, are able to convince both the public and the servants of the public that the usual professional fees are unnecessarily high.

This brings us easily to our second inquiry—the causes of the bad-



TOWN HALL, NORTH EASTON, MASS.

ness of our municipal architecture. All things considered, the wonder is that it is not worse. Thorns and thistles do not produce grapes and figs at the end of the nineteenth century any more than they did at the beginning of the first, and there is no reason to expect visible improvement in the character of our municipal architecture while the present methods of obtaining and selecting plans for them prevail. It would be almost as reasonable to entrust the cutting and fitting of our clothes to the family butcher, on the ground that cutting is at least a part of his practice, that he has always been accustomed to wear clothes himself and has often observed them on other people, as to expect the average, or even the unusually intelligent, members of a city government to decide wisely on matters that require long, thorough, special training and experience. This is far from saying that the average city officials are not honest and able men in their respective vocations and professions; their ignorance of architecture is no reproach to them or evidence of unfitness for their office; the reproach lies in their willingness to judge for their cotemporaries and for posterity concerning matters of which they are necessarily ignorant. Even this willingness need not be ascribed to excessive conceit,—there is a certain percentage of modest men in all positions; it is the result of time-honored, or rather of time-dishonored practice. The difference between good and bad architecture is not only unperceived, it is not considered important. In the popular estimation excellence in this, the noblest, the most influential, the most enduring, and at the same time the most complex of all the arts, is a mere matter of fancy or of fashion, depending on familiarity or individual caprice. With by far the greater number of people who think of the subject at all, different forms and expressions in architecture, or what they suppose to be architecture, are thought beautiful for precisely the same reasons that the bonnets this year are considered more beautiful and becoming than those of last year. In neither case is there the slightest perception of any quality that is intrinsically and permanently beautiful.

And yet a thing of beauty is a joy forever, and we know that there is an architecture that has been not only an inspiration but a delight to all lovers of the beautiful; it has given world-wide and immortal fame to the people who created it and to the places where it stands; it has roused the patriotism, strengthened and sustained the public spirit, of the people who have dwelt within the light of its influence.

Allowing all details of sight, construction, sanitation, arrangement of floor plans, to be included in the legitimate scope of architecture,—a large allowance by the way,—there is no doubt that the sound judgment and common-sense which we have a right to predicate of those selected to transact public business may very properly be added to the skill of the architect, but these tithes of mint, anise, and cummin must not be esteemed above the weightier matters which alone give enduring value to architecture. It goes without saying that constructive skill and ingenuity in planning belong to every competent architect's equipment, but the "practical" architects who make a specialty of certain constructive methods, and claim superior ability in some one or more of the subordinate features of building, are not likely to attach a true value to the essential and enduring elements of architecture.

COURT HOUSE, SPRINGFIELD, MASS.

CITY LIBRARY, CAMBRIDGE, MASS.

In these piping times of competition, when towns and cities seem more anxious to grow by increasing the number rather than by improving the quality of their inhabitants, a common cause of architectural mediocrity or worse lies in the popular notion that " home talent " must be encouraged. If the results of this home talent in architecture passed away with the passing of its possessor, like the work of the merchant, the banker, the tailor, and the butcher, there would be less danger from this sentiment. Since the work of the architect remains as a permanent bane or blessing to an unlimited posterity, the shaping of such bequests becomes a grave responsibility, demanding something more than the accident of residence, which at most is but temporary.

So I repeat that the first step towards the improvement of municipal as of all other architecture will be the employment of competent architects, wherever they may be found ; and second, the leaving of all questions of relative architectural merit to those who, by education, experience, refined esthetic instincts, and judicial quality, are competent to answer them wisely. I might add, and by eliminating politics from all public work ; but when that happens we shall be ready for that realm where houses are not made with hands.

It is difficult to draw a line between utility and esthetic considerations. Indeed, it is mainly a matter of definitions. It is certain that no public building is fit for its place whose visible form is not its own sufficient reason for existence. It must be complete and homogeneous: free from fantastic tricks and affectations. Whether it be Greek or Gothic, Romanesque, or some form of Renaissance, or of the style yet unborn which may some time be evolved, not from chaos but from the greatest and best that has been done in the past, it must be of a pure and distinct type. Freaks and aberrations have always been and always will be in private architecture. They have no place in buildings that represent the dignity, the permanence, the wisdom, and the wealth of an intelligent community, of a great municipal corporation; and any attempt to make the details of a building, or some curious and irrelevant excrescences, atone for or conceal inherent defects of form must always fail. A poor, misshapen clown cannot be converted into an Apollo by placing a helmet on his head and a lyre in his hands.

Doubtless the most serious faults of contemporary architecture arise from the lack of a clearly defined purpose, of a distinct recognition of the thing to be expressed, and then, when this is somewhat vaguely apprehended, of vacillation and uncertainty as to the best means of producing the desired effect. As in verbal expression, indistinctness, incoherency, and feebleness are commonly the result of indistinct, incoherent, and feeble thinking, so, until the scope and purpose of a public building—or of any other for that matter—stand out clearly in the minds of those who are to determine its form, there will be only incoherency and stammering in its utterance. One of the great charms of Richardson's work is that his trumpet gave no uncertain

PUBLIC LIBRARY, BOSTON.

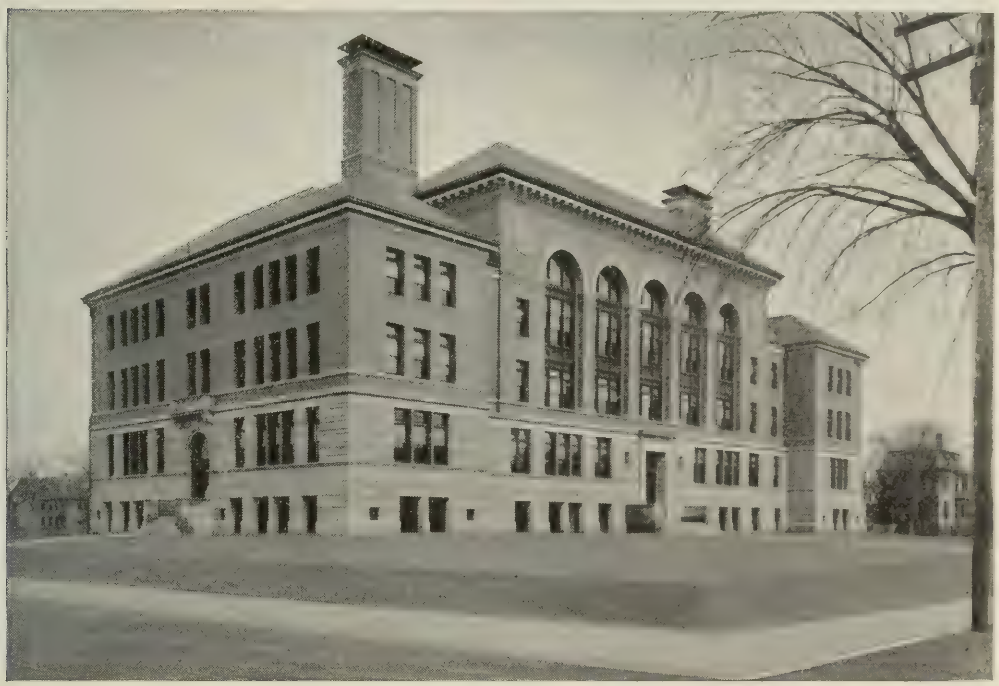
sound. The same is true of the rich French and Flemish work. It is unmistakably Gothic and the same Gothic that we are accustomed to call ecclesiastical. Yet not for a moment would one mistake these buildings for churches. And it may be said here of all these illustrations that each in its way, and with more or less complete success, is an attempt to accomplish a distinct and beneficent purpose, in faithful accord with the conditions existing at the time it was built. They are not good because they are of one or another architectural style, but because through them men of practical skill and spiritual insight have clearly expressed a noble purpose.

Whether the city hall and the other public offices are under one roof, or consist of a more or less detached group of buildings, they should have, at whatever cost to the city, spacious grounds, visible architecture of the highest type, and the best possible construction. For they reveal the public spirit, the general cultivation, the harmony of the citizens, and their ability to coöperate in good work, without which there can be no permanent and healthful growth. It is possible by good architecture to create such an enthusiasm that, instead of feeling that they are acting unwisely in appropriating money to add to the beauty of the city and enlarge its reputation for liberality and good taste, its citizens will rather desire to do more in the same

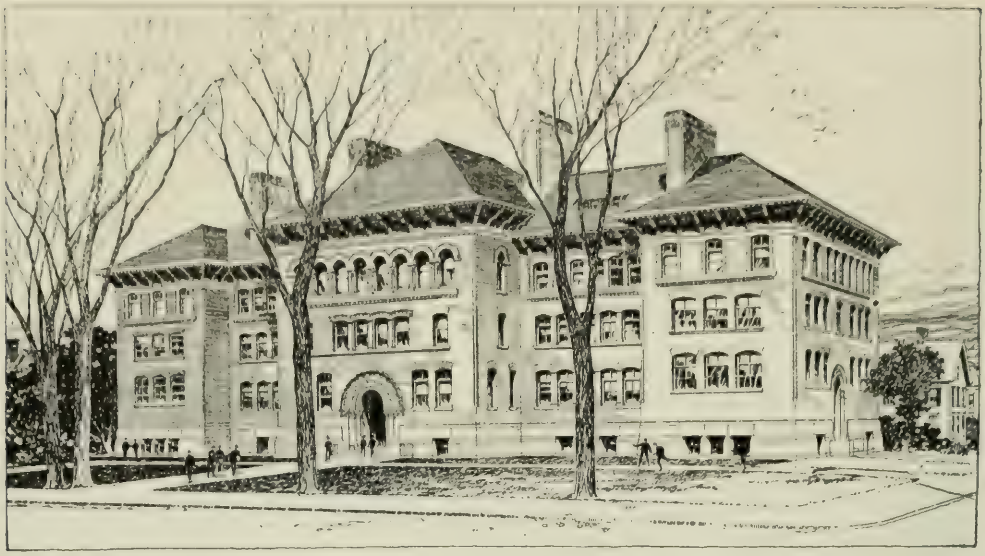
PUBLIC LIBRARY, QUINCY, MASS.

direction. Men in the mass are strikingly like the same men as individuals. They are willing to pay liberally for that which satisfies them, especially if it is admired by others; but they abhor being defrauded by dishonest and incompetent juries, architects, or contractors.

Generally speaking, the most satisfactory buildings, those which have held and are likely to hold the admiration of the world, regardless of time and place, may be grouped in three classes (I make this classification with some diffidence and ought, perhaps, to put it in the form of a question): first, those which, as to their exterior designs, are simply utilitarian in the common meaning of the term. That is, while certain parts may be exaggerated beyond the strict requirements of use, the parts themselves are essential. There is no ornament, no attempt to give a decorative effect to any feature beyond what is obtained by a careful study of forms, by frank, natural composition and by well-chosen color. The second class would include buildings in which the main structure is utilitarian, but to which some distinctly monumental feature is added. This may be an ornate porch, a dominant gable, a cupola or dome rising from the roof, or a tower, more or less independent of the main building in its construction, and distinctly detached from it in significance; the building being rigidly adapted to its use, the tower as frankly serving a purely esthetic purpose. The third class would include buildings in which the whole,



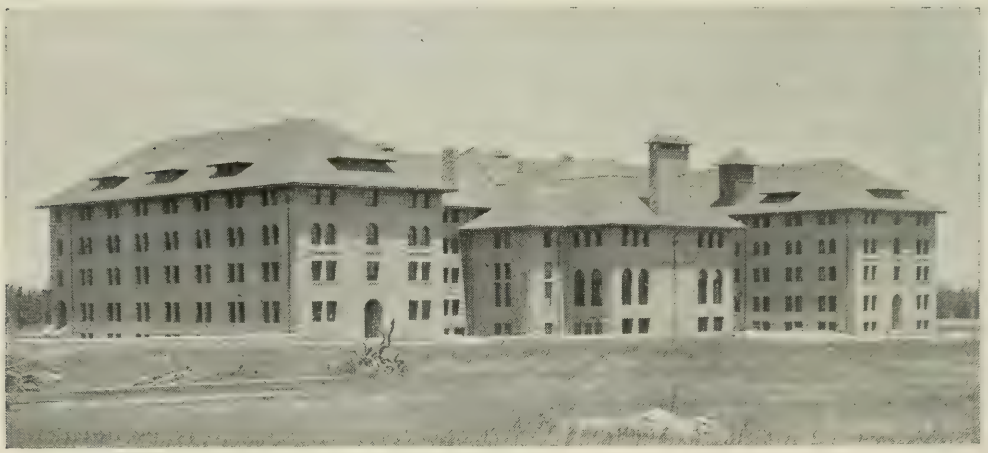
HIGH SCHOOL, CAMBRIDGE, MASS.



HIGH SCHOOL, MALDEN, MASS.

while serving perfectly its legitimate use, is in appearance monumental; where no single feature is exalted above the rest, but where the entire visible building—roof, windows, and walls themselves—is treated decoratively, all its parts combining to produce one grand, harmonious whole.

To attach useless features and trivial decoration to a simple, unpretentious building indicates both vanity and poverty. It is infinitely better to let it remain in absolute and uncompromising simplicity. Having once decided to make a simple building, let us have the courage and wisdom to stick to it; having decided to give the simple building some feature of dignity and esthetic value, let us decide what that shall be, and avoid detracting from it by nervously attaching other minor features to divide its honors. What a fatal loss it would be to



DORMITORY OF THE STANFORD UNIVERSITY AT PALO ALTO, CALIFORNIA.

the beautiful Palazzo Publico of Sienna, or the Vecchio of Florence, if their stately towers could be made over into half a dozen minor turrets. Or suppose the central feature of the Hotel de Ville of Antwerp had been cut up into a variegated collection of insignificant dormers and pinnacles!

How to combine the utilitarian and the monumental without sacrificing either is one of the most serious problems in architecture. To make all our public arch tecture, whether simple or complex, whether utilitarian or monumental, of commanding dignity and grace is the duty laid upon those into whose hands the task is committed. For, more than any other material thing, its architecture fortifies and enriches a nation and indelibly records its history.

PLANNING THE SITE FOR A CITY.

By Lewis M. Haupt, C. E.

SO long as new territory remains to be developed, new centers of industry must spring up which may ultimately attain to the dignity of cities. But the projector of a town cannot always forecast the ultimate needs of the community with sufficient prescience to adapt his plans to them, nor is it often that he cares to do so, his main purpose being to realize quickly upon his resources.

New "town-sites" are not generally laid out by engineers or philanthropists who desire to secure the best possible results for all time, but by speculators who may never have seen the site—much less have had a topographic survey of it upon which to base the most economic plans for streets, grades, drainage, water-supply, sewerage, and the many other requirements of a large community. Often these elaborate paper projects cover marshes, dunes, terraces, or even inaccessible escarpments, but, so long as the demand for lots exists and the investor is willing to take the chances, it matters little to the "boomers" how serious the errors of location or design may be, or how greatly the cost of maintenance may be augmented by physical obstacles to habitation, transportation, or sanitation,—the three principal elements of a site. These mushroom cities are handicapped from the start, and it is not until some great fire or desolating pestilence teaches its lesson, that proper measures are taken to render the locality suitable for habitation.

A comparative study of the plans of existing cities, considered each with reference to the local topography, would prove interesting and instructive. The old fortified cities of continental Europe, with their walls of circumvallation, radial highways, moats, canals, and ditches present many and varied features of interest. Their location was often selected with reference to the strategic requirements of the times and the current methods of defense, but these considerations are not pertinent to the selection of suitable sites for and the proper planning of large cities in America to-day.

It should be considered, first of all, that certain sites can never be expected to support relatively large cities, while others, from the nature of their environments, can scarcely avoid having greatness thrust upon them. The presence of extensive mineral deposits is not in itself sufficient, but if there be a natural source of power, and, still more important, cheap, available transportation facilities, the prospects for a city are very good. But the best conditions exist where a large tonnage of any kind, especially of agricultural products, is transshipped and stored. Such conditions are presented where land and water systems of transportation meet, or at the head of navigation.

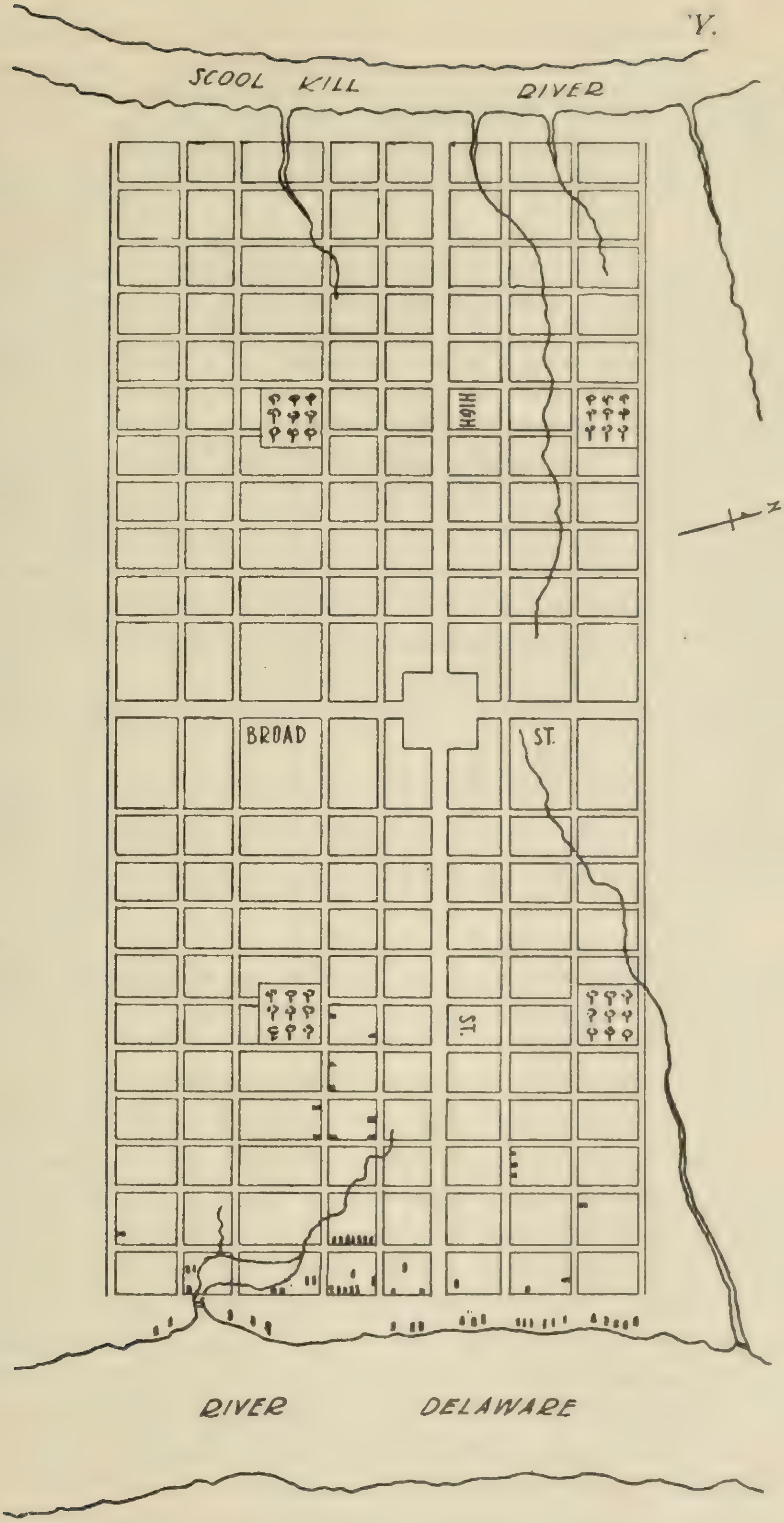
It should be noted that in the United States the great cities have followed the course of the Star of Empire and are on the western side of the waterways, as centers of distribution from the landings on the rivers and lakes. The area of the tributary territory accessible by water is also an important factor in determining the prospective size of a commercial center. Thus the phenomenal growth of Chicago is readily understood, and she has not yet attained the zenith of her glory, for the magnificent waterway now under construction connecting her port on Lake Michigan with the Illinois and Mississippi rivers will greatly stimulate her manufactures and increase her population. New York city, situated at the reëntrant angle of the Middle Bay on the Atlantic, has three-fourths of the circle of tributary (land) territory from which to draw her tonnage, and is therefore more favorably situated than any other tidewater point on the Atlantic coast. The Erie canal was the determining factor in raising her to the proud distinction of the American metropolis. She still needs increased interior deep-water communications to the south for coal and lumber and to the north for cereals and dairy products. If transportation facilities were equal, the "Zenith City of the Unsalted Seas" would have as good a *raison d'être* as Chicago, having the same water distance to traverse via the lakes to eastern ports, and an immensely productive territory from which to draw supplies; but the Chicago drainage canal will forever turn the scales in favor of the latter city, where, despite the marshes and lack of even sufficient slope for drainage, the imperative demands of commerce have determined the location of our western emporium.

It is not difficult therefore to determine in advance whether the location proposed must be planned for a large, medium, or small population, and the designs may be modified accordingly by giving due weight to the geographical, topographical, geological, meteorological, and physical elements in the selection of a site. In this respect, while the northern latitudes have many favorable features, the ports on the Great Lakes are closed more than one-third of the year. On the other hand, while the southern ports on the Gulf of Mexico are open all the year, the high temperatures have hitherto prevented the storage of perishable freights, but the rapid increase of cold-storage warehouses is in a measure eliminating this objection. Taking all the conditions for the existence of a great city into consideration, it is believed that there is no locality better adapted to the development of a commercial metropolis than the northwestern angle of the coast of the Gulf of Mexico. With the removal of the bar which separates the harbor from the commerce of the world, there will be a magical city springing up by the sea which should rival Venice in her palmiest days. The eastern cities are limited in their territory by the long-rail haul over numerous chains of mountains, so that the lines of least resistance for the trans-Mississippi region are either gulfward or lakeward. The early construction of the Nicaragua canal or the Tehuantepec ship railway, or both, will add weight to these suggestions as to the future of our gulf cities.

But it is not only the probable size of the city that should be considered in the nucleus of the plan. Its principal characteristic, as determined by the occupation of its inhabitants, is also an important element in the distribution of its population, and in the provision to be made for all kinds of service. Thus, for a commercial center, the greatest stress must be laid upon ample terminal facilities, warehouses, piers, elevators, and yardage, with convenient markets, exchanges, and chandlers, and accessible residence quarters. The conditions in a manufacturing town will be materially changed as to the character of the service and distribution of population, while for a capital or legislative center other plans are more suitable. All plans are largely influenced, however, by the local topography, and the prevailing mistake is made of placing the first highway parallel to some line of communication, be it common road, railroad, or water-course, and using this as a base from which to lay off a rectangular system of streets. This error requires grades which sometimes exceed 20 per cent. from the water frontage back to the plateau, and greatly restricts the commerce by adding to the terminal expenses as well as to the difficulties of laying and maintaining service-mains for the city.

Probably one of the earliest and best-considered attempts to plan for the future of a great city was that of William Penn in founding his colony on the Delaware. Although, in the two centuries which have elapsed, Philadelphia has far surpassed the most sanguine expectations of its projector, it still deservedly retains the distinction of being, *par excellence*, "The City of Homes." The wisdom and foresight of its founder are illustrated by these extracts from his instructions to his commissioners, William Crispin, John Bezar, and Nathaniel Allen:

> The creeks should be sounded on my side of Delaware river, especially Upland, in order to settle a great towne, and be sure to make your choice where it is most navigable, high, dry, and healthy. That is, where most ships may best ride, of deepest draught of water, if possible to load or unload at ye Bank or key side, without boating or litering it. . . .
>
> Such a place being found out for navigation, healthy scituation, and good soyle for provision, lay out ten thousand acres contiguous to it in the best manner you can, as the bounds and extent of the libertyes of the said towne. . . .



PLAN OF PHILADELPHIA, 1683.

> the Gulf of Me[illegible] the figure of the Towne so as yt the streets hereafter may be uni- the harbor [illegible] the Water from the Country bounds, lett ye place for the store house [illegible] middle of the Key, wch will yet serve for market and State houses too . . . let the Houses be built in a line, or upon a line as much as may be. . . . The Distance of each House from the Creek or Harbor should in my judgt a measured quarter of a Mile, at least two hundred paces, because of building hereafter, streets downwards to ye Harbor.
>
> Let every House be placed if the Person pleases in ye middle of its plat as to the breadth way of it so that there may be ground on each side, for Gardens or Orchards or fields, yt it may be a greene Country Towne, wch will never be burnt and alwayes be wholesome. I Judge yt you must be guided in yor breadth of Land by wt you can get yt is unplanted and will not be parted wth, but so far as I can guesse at this Distance me thinks in a Citty, each share to have fifty Poles (855 ft) upon ye Front to ye River, and ye rest Backward will be sufficient.

It would appear that Philadelphia was designed to be a commercial city, and that ample provision was made in Penn's plans for a comprehensive frontage. Unfortunately this rule has not been observed, and, now that it is proposed to expend about $8,000,000 in removing the obstructions to commerce and reconstructing the harbor front, the city is embarrassed by innumerable legal and physical obstacles, brought to bear by riparian owners. In reply to a question as to the rights of freeholders to build vaults in the high banks along the river front, William Penn wrote in 1684:

> The bank is a top common, from end to end. The rest next the water, belongs to *front lot* men no more than *back lot* men. The way bounds them. They may build stairs, and at the *top of the bank*, a *common exchange*, *or walk*, and against the street common wharfs may be built freely; but into the water, and the shore, is no purchasers.

In consequence, Philadelphia soon became the most prosperous commercial city of the continent, and maintained her supremacy until the opening of the waterways to the west, via the Erie canal, (in 1826) transferred it to New York.

As this river frontage was acquired by Stephen Girard, it will be of interest to note that in his will, dated February 16, 1830, he sets apart $500,000 for many public purposes and, *inter alia*, "to lay out, regulate, curb, light and pave a passage-way or street . . . fronting the river Delaware, not less than twenty-one feet wide, . . . to keep clean all docks, . . . to pull down all platforms carried out from the east part of the city over the river Delaware on piles or pillars." Yet this is the part of the frontage where the avenue is now to be widened to 150 feet and where "open" or pile piers are to be built over 500 feet in length. Such are the exigencies of commerce. Penn's plan, if followed, would have enabled the city to retain control of this magnificent franchise, to her great benefit and profit.

Another illustration from the history of our American cities is the carefully-matured plan that was prepared for the national capital. It was laid out by Andrew Ellicott, C. E., after the plans of Major Pierre L'Enfant,* and one of the original prints may be seen among the relics filed in the Washington manor at Mount Vernon. The title reads: "Plan of the City of Washington, in the territory of Columbia, ceded by the States of Virginia and Maryland to the U. S. of America, and by them established as the seat of Government after the year MDCCC. Engraved by Thackara and Vallance, Phila., 1792." This plan was the nucleus of the present city. The notes on its face read as follows:

> The grand avenues and such streets as lead immediately to public places are from 130 to 160 feet wide, and may be conveniently divided into footways, walks of trees, and carriage-way. The other streets are from 90 to 110 feet wide. In order to execute this plan Mr. Ellicott drew a true meridional line by celestial observation, which passes through the area intended for the Capitol; these lines he crossed by another, due east and west, which passes through the same area. These lines were accurately measured and made the basis on which the whole plan was executed. He ran all the lines by a transit instrument . . . and left nothing to the uncertainty of the compass.
>
> OBSERVATIONS EXPLANATORY OF THE PLAN.
>
> I. The positions for the different edifices, and for the several squares or areas of different shapes, as they are laid down, were first determined on the most advantageous ground, commanding the most extensive prospects and the better susceptible of such improvements as either use or ornament may hereafter call for.
>
> II. Lines or avenues of direct communication have been devised to connect the separate and most distant objects with the principal. Attention has been paid to the passing of those leading avenues over the most favorable ground for prospect and convenience.
>
> III. North and south lines intersected by those running due east and west make the distribution of the city into streets, squares, etc., and those lines have been so combined as to meet at certain given points with those divergent avenues so as to form on the spaces "first determined" the different squares or areas.†

Here then is a typical plan based upon topographic sites for the principal buildings, connected by "air" lines of ample width, and a street system oriented on the true meridians, yet with a distinct purpose and no serious obstructions to the execution of the plan. Washington has ever been known as the city of "magnificent distances." Its reputed beauty is due largely to the complete revision of its grades and pavements under the régime of Alexander R. Shepherd, a quarter of a century ago, and its systematic prosecution by the District commission since that date. But while admirably adapted to the purposes of a national capital, the plan would be an unwarranted extravagance under ordinary municipal management. Few cities could afford to sacrifice 43 per cent. of their total area to street uses with the heavy expenses of maintenance. Great widths are not required for traffic or even for sanitation, the tendency being to neglect the untraveled portions, which in consequence become obnoxious. The "lungs" of the city had better be concentrated in squares or parks at frequent intervals and off the thoroughfares, leaving the streets to be designed only for their legitimate uses of traffic. Even for a large business, the best width for streets will be found to approximate to the four rods (66 feet) so common in our large western cities, although this is wider than is necessary for all streets. On the other hand, the boulevards, of which there may be a limited number, should exceed 100 feet.

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* The history of L'Enfant's plan becomes almost pathetic. Leaving France on the outbreak of the American revolution, he joined the Federal army and soon won the confidence of the Commander-in-chief for his courage and ability. After the close of the war he took up his abode in Philadelphia, and upon the cession of the District of Columbia to the United States as the seat of government, in 1791, General Washington appointed Major Pierre Charles L'Enfant to design the plan for the future capital. This he did with his usual skill, but on being requested to surrender his plan to the commissioners for publication, he declined on the ground that, if they were made public, speculators would select the best sites and build rookeries thereon, thus marring his ideal. He was accordingly relieved from the duty on March 1, 1792, and Andrew Ellicott, afterward geographer general of the United States, was appointed in his stead. Before the close of the year 1792 a new plan was prepared following as closely as might be the suggestions of L'Enfant, and the commission, at the President's suggestion, sent to the latter 500 guineas and a choice lot of ground for his former services. These he insolently declined, and the last years of his life he spent in haunting the lobbies of Congress, trying to secure compensation. He died in poverty about 1825 at a manor overlooking the site of the city, and was buried under a solitary cypress which marks his unhonored grave. (See "The Story of the City of Washington," by Todd, published by Putnam, 1889.)

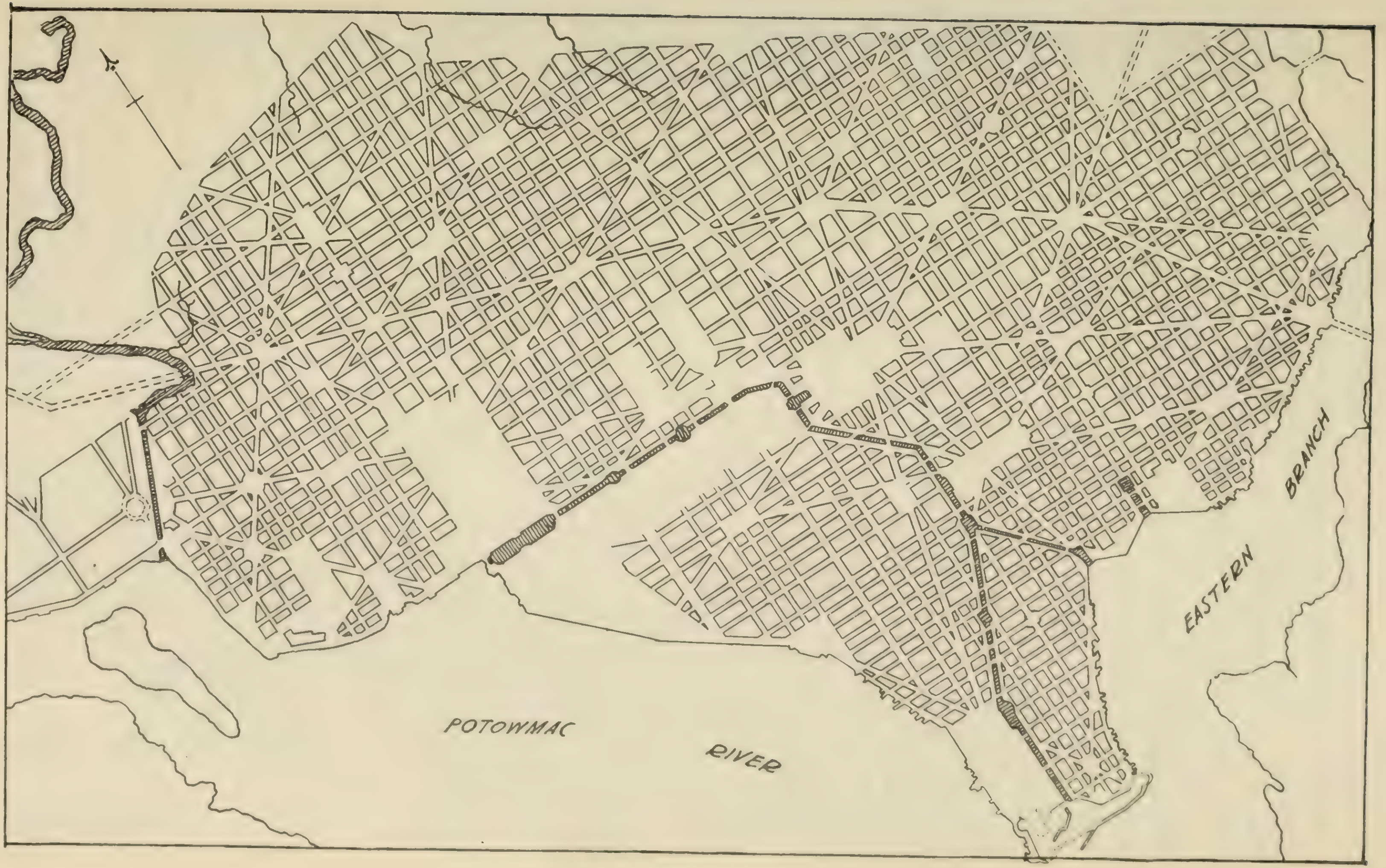
† For these notes acknowledgment is due to Harrison H. Dodge, Superintendent of Mount Vernon.

The streets 50 feet wide as designed for Philadelphia by the proprietor are now found to be too narrow for the purposes of traffic since the city is gridironed by street-car tracks. These occupy the crown of each street, leaving less than nine feet clearance on either side between track and curbs and causing frequent obstructions. Yet in laying out new towns and villages in suburban districts fifty feet is thought to be a liberal width, while country roads are more frequently either two rods or thirty feet, with no provision for widening near cities.

The relative directions of the streets with reference to each other and to the meridian also merit consideration. The effort is too frequently made to locate the lines of travel on the cardinal points of the compass. The result is too great exposure to the sun in some quarters and not enough in others. The diagonal orientation, on the other hand, would provide a more equable distribution of the solar influences with better sanitary results.

Whether the blocks should be square or rectangular will depend upon the unit or size of the lot. Ordinarily the rectangle is considered the better plan, with a ratio of about 1 to 4 or 1 to 5 for the lot and 1 to 2 for the block; that is, the lots may average 25 × 100 or 125 feet, while the blocks may run 250 × 500 feet.

But these matters of detail are usually determined by the whim of the property-owner, whose interest it is to cut up the farm so as to produce the greatest revenue irrespective of adjacent requirements.

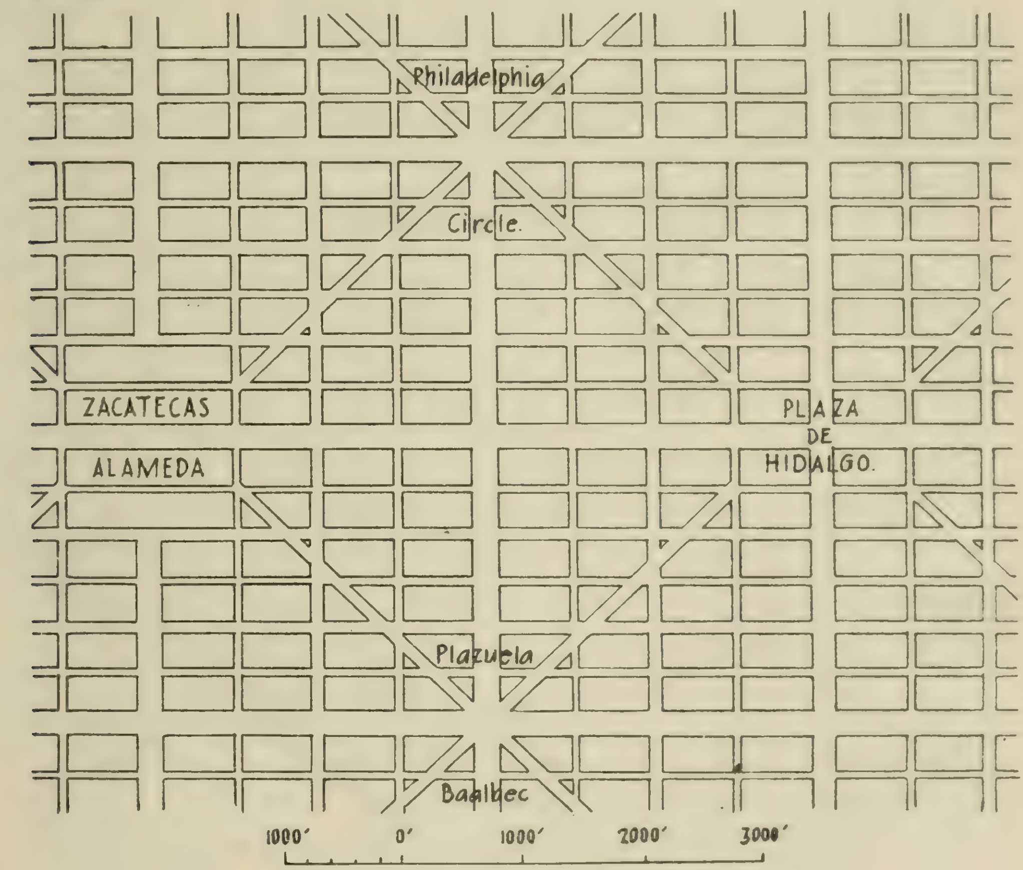


PLAN OF WASHINGTON.

Hence many new cities are mere aggregations of ill-conditioned and discordant suburbs, which, like "Topsy," had no training, but "just growed" to a congested maturity, burdensome either to endure or to remove. To prevent these labyrinthian appendages, in some western States, legal enactments now require each addition to be submitted to some central authority which must first approve of the plan and see that it accords with the adjacent plats in its general features. The full bearing of this point may be seen from an inspection of an atlas of almost any rapidly-growing suburban town in one of the older States, the several land-owners having been at liberty to divide up their properties at will. It will be noted that the streets are short disconnected passage-ways, and that their total length is greater than would be required for a much better service on a preconceived general design. The maintenance of this abortion imposes unnecessary expense upon the town for all time, and, although the original owner may secure a few more dollars for his tract, he has in the aggregate to construct and maintain a greater length of streets. This is generally done in the cheapest and most primitive way and with little or no provision for drainage or water-supply, until these heterogeneous plats are incorporated into a borough or town, when the taxpayer must pay a higher rate to maintain or correct the errors of grade alignment, drainage, and other municipal service.

Concerning the distribution of the population, where it is homogeneous and does not exceed the sanitary limit of 100 per acre, there is no necessity for any other than a rectangular system of streets, if the town is always to remain limited in size,—to, say, one square mile or 64,000 population. But when it runs up to the hundreds of thousands, it is evident that numerous convergent avenues must be provided from different centers to meet the enlarged requirements of travel. Upon this sanitary basis, with five to a family, and but one family to a residence, there would result twenty lots to the acre, and, if 33 per cent. be taken for street areas, there will be left 29,040 square feet for the twenty lots, giving an average of 1452 square feet, or lots 15 × 96.7 feet, a size small enough for the most avaricious. This, however, is for the greatest permissible density of population, and is a limit which is seldom adopted. Under this limitation a city of 1,000,000 inhabitants would require 10,000 acres, or 15.6 square miles—a tract nearly four miles square—with diagonals of 5.6 miles. Unless such diagonals were provided in the original plan, it would require a space of eight miles to be paved in moving from one corner to the opposite diagonal. Such divergent or radial lines would increase the available assessable frontages more than they would diminish the available building area, and are therefore fully warranted public improvements, for which provision should be made on the best topographic lines in the location and orientation of a large city.

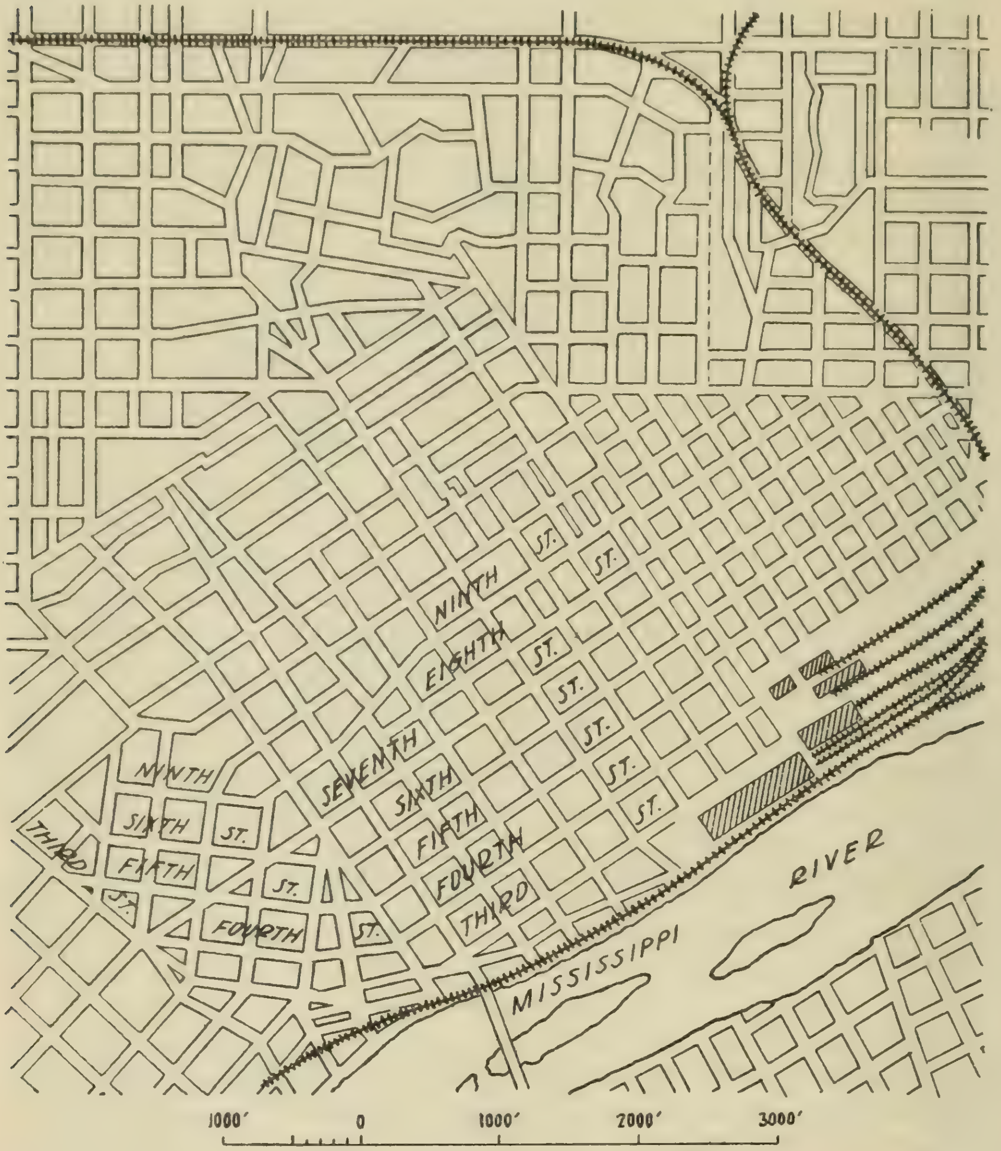
The ideal design of Gonzalez City, on the bay of Topolobampo, Gulf of California, furnishes an illustration of variations in width and directions of streets with numerous plazas, alamedas, and rondos, but laid out with a geometric regularity which can scarcely adapt itself economically to an extended terrane. The parks also are too numerous and extensive, and interrupt the continuity of some of the principal avenues.



PLAN OF GONZALEZ CITY.

In the old portion of the city of St. Paul, Minnesota, will be seen an abnormal outgrowth of circumstances, where near the "Seven Corners" the street named Second runs into Third, while Third intersects and extends across Fourth, cuts Fifth at its terminus, and is parallel to part of Sixth. So in one place the numbers of the streets taken consecutively read Third, Fourth, Fifth, Seventh, Sixth, Ninth, and Tenth, with no Eighth street. The topography of the site is peculiar, as it rises in three terraces from the flats and is intersected by a ravine which enables the railroads to pass from the river bank to the plateau. The variations in lots and blocks of the numerous additions are shown on the small section of the map selected as a type.

It is impossible to enter here upon a minute analysis of the numerous types of city development, or to elaborate upon the enormous expenditures required to overcome their original defects. It is a matter of more moment to a city that her plan should be carefully adapted to the topography, and the physical obstructions to urban traffic be removed, than that similar care and skill be bestowed upon the location of a railroad or other communication with outlying districts. Hence we are forced to the conclusion that, the size and location having been



PLAN OF ST. PAUL.

determined, the form or direction of growth must be governed largely by local physical conditions. The presence of a commercial frontage will manifest itself by a prolongation along the water. Thus Chicago has a length of twenty-four miles and a depth of only eight miles. Manhattan Island is about 13½ miles long and two wide, giving about twenty-eight miles of frontage.

It will be seen that no absolute rules can be laid down, but that the topography must exercise the predominating influence and suggest the plan. If the site selected does not lend itself naturally to a rectilinear plan with occasional diagonal thoroughfares, then the curvilinear or angular, divergent or serpentine may be adopted, if, by so doing, distances may be reduced and grades (except for drainage) be avoided. By all means the formation of towns. and cities by the aggregations of individual plats laid out to suit the owner should be avoided even by prohibitory legislation.

There exists to day in all civilized countries a strong tendency towards concentration in social and business centers, and the effect is manifest in the rapid growth of cities by the removal thereto of the rural population. Wherever favorable conditions exist, there will be found springing up a hamlet, borough, village, or town which in a few decades may expand to the dimensions of a city.

In any event, provision should be made both in the selection of the site and in the preparation of the plan of such a nucleus for its ultimate expansion, and much will be saved if the advice of some competent engineer be solicited in advance as to both these points. Even the character of the soil upon which a town may be built plays an important part in the sanitary condition of its inhabitants.

The purity and cost of its water supply as well as the facilities for sewage disposal are also functions of the site which should be selected so that these may be provided for, to a large extent, at least, by gravity, and without contamination of the streams serving other localities. Hence the desirability of professional advice.

THE SELECTION OF MOTIVE POWER.

(FIRST PAPER.)

By Charles E. Emery, Ph. D.

IN selecting a motive power for a new manufactory a prudent manager would naturally inquire if there were any new developments on the subject, and ask as to the relative standing of well-known means in view of modern improvements. The inquiry cannot be limited to apparatus required for a particular purpose, subject to the conditions which obtain at a particular place, but must indicate the principles of selection for differing conditions, and may even involve the examination of a location with reference to its advantages for obtaining not only power, but suitable labor and accessible markets. The subject is, therefore, necessarily approached in a general way. We should at first realize that all power in sufficient quantities for manufacturing purposes is obtained by utilizing in some way one or more of the various forces of nature. The energy of the sun expended in lifting the vapor of water to the clouds is returned and in part utilized by man as the aggregated rain drops find their way in the streams from the slopes to the sea. To the same source of energy the changeful winds owe almost exclusively the motion and force familiarly utilized on sea and land. Even the heat derived by burning the trees of the forest represents a portion of the energy of the sun, which has changed inorganic incombustible matter into organized combustible tissue and fiber, and thereby stored up energy in the past for use in the present. It is more important than all to recollect that this operation has been going on for ages, and that our coal fields and supplies of mineral oil represent also the energy of the sun stored in prehistoric vegetation buried in the earth and transformed in the laboratory of nature. Abstractly, then, the question is whether we shall derive our motive power from the sunlight of the present or from that of the past. A prominent distinction at once appears. All direct forces from the sun now available, whether they be from the winds or the waters, are of the varying character familiar in everyday life; whereas energy stored, whether in the form of coal, mineral oil, or even wood fiber, can be expended to produce heat and power at will. On the same principle the varying forces derived from water can be better utilized by the various familiar systems of storage. It would appear, then, from considerations of a very general nature, that the most reliable power must be secured from mineral fuel, consumed at will, and the power next in reliability, from water stored in great natural reservoirs.

The power derived from the fuel must in general be obtained from a heat engine, of which the steam-engine is the most familiar type and that most generally employed. The steam-engine has therefore become the standard to which the cost of all sources of power are referred, although in special locations power may be obtained more cheaply in another way.

Water is a primary source of power, as the potential energy due to its elevation may be directly transmitted into mechanical work. Steam is, however, a secondary source, as it is only a means of transmuting into mechanical work the energy stored in the fuel and available as heat. Both primary and secondary sources may easily be confused with mere means of transmission. Electricity is nòt a source of power. It may be made a secondary source in the same sense as steam, by the discovery of a practical method of generating it on a large scale from the direct combustion of fuel. At present it is only a means of furnishing at one point power developed at another, and in this respect stands in the same category as hydraulic and compressed air transmissions, and, except for some purposes relating to the distance covered, acts on the same principle as transmission by wire ropes, belts, or ordinary shafting. Every means of transmission must be operated by a true source of power, like a steam-engine or a water-wheel, and in the abstract, where the greatest efficiency is obtained, the efficiency is higher the less the number of parts interposed between the source of power and the point where the same is utilized. Transmission of steam is distinguished from the above by the fact that it permits the boilers to be located at a convenient point and the steam to be used where heat or power are required.

Approaching the details of the subject, we first call attention to the fact that the power available by the use of windmills is by no means small or valueless. They make the continuous drainage of the lowlands of Holland practicable, and mills requiring 80 horse-power and upwards are successfully operated by a single wheel. The system is not, however, well adapted for locations where the wind is light and variable and where coal is as cheap as in most locations in this country. In some places along the coast the wind blows so much of the time, and so strongly in one direction, that isolated trees lean away from it and are distorted by having foliage principally on the leeward side. These living wind vanes clearly point out the possibility of using windmills for power in such localities. There are many things, however, to think of before making such an installation. In the best location the wind is liable to fail at inopportune times, and a given output can only be obtained by frequently working during the night. Such a system would therefore not be popular where the general feeling of labor organizations, and indeed of all wage-earners, leans towards a definite number of hours of labor and a definite output in proportion thereto, with the remainder of the day available for social enjoyment or mutual improvement. Where the labor can be changed from one place to another, as on a farm, windmills are very useful, and particularly where fuel is scarce. The windmill manufacturers make many sales in the West and other parts of the country where the conditions warrant the use of such a power. Windmills as we know them in this vicinity are chiefly used for pumping water, and, being of the American automatic type, care for themselves under all possible varying conditions; and although water is pumped only when there is sufficient wind, it is stored in tanks and thus made available for use when the wheel is at rest. Competition has made this type surprisingly cheap. Mr. Brush, the electrician, constructed at his country-seat an experimental plant in which a windmill was used to generate electric current and charge storage batteries from which such current was utilized about the premises. This system has recently been suggested by others for general use, and should be feasible and possibly profitable in favored locations if operated on a sufficiently large scale to warrant the employment of the skilled labor necessary to keep in order the batteries and other apparatus, particularly the several automatic devices necessary to practically convert a changeable source of supply into energy available continuously.

Leaving the general question of water power until it can be conveniently compared with steam power, we will examine the availability of heat engines other than steam-engines. Hot-air engines have not come into general use for miscellaneous power purposes. They are practicable on a large scale by the use of temperatures and pressures so high as to prohibit in a sense general use. There are, however, some small engines largely used for pumping purposes which work within such reasonable limits as to give little or no trouble. The original form is that designed by Ericsson. In the base of the apparatus a small fire of gas or coal is kept burning and heats directly a shell pendent from a cylinder containing a piston with pendent plunger, between which and the hot bottom cold air is forced as the plunger rises, which, being heated, completes the upstroke, when an exhaust valve opens, the plunger is returned by the action of a fly-wheel, and the operation is repeated. The Rider hot-air engines operate successfully on a very similar principle, but with entirely different details. Both these forms of engines are used by ordinary help to pump water from the street mains to an elevated tank. There is no possibility of an explosion, and the danger of overheating is entirely prevented if the operator once gets the pump started, for then any extra heat only increases the speed.

Gas and petroleum engines of various kinds are largely used for power purposes. In one form of the latter, used largely in naphtha launches, naphtha stored in tanks on the vessel is injected into a coil heated by a naphtha lamp, and the resulting naphtha vapor is used in a small engine like a steam-engine. Generally, however, naphtha or crude petroleum is sprayed directly into the cylinder of an engine, where it is vaporized by the heat, when the operation is the same as in a gas-engine,—viz., the vapor or gas is mixed with air and exploded by a fixed torch, causing intense pressure utilized on a piston, and a high temperature controlled by a water jacket. Gas and petroleum engines have some advantages for detached locations, where they receive only the occasional attention of careful but unskilled labor, as the operations are all automatic. A comparatively small quantity of naphtha or oil is placed in a tank at the base of the petroleum engine, and, with the same reasonable care that would be exercised in handling petroleum for lamps, there is little danger of fire. In general, the larger quantities of oil are stored outside in underground tanks, and in some cases it is provided that no store is kept about the engine, but the quantity required for each stroke is withdrawn from the tank outside by means of a pump. Where gas is available from a street supply, the installation of a gas-engine is simpler than that of a petroleum engine, as it only requires a pipe connection to the gas service ; otherwise the two forms of engine are generally very similar in appearance, construction, and operation. There is some jar and noise due to the explosions, which must be provided for in locating the engine in dwellings. Generally by bedding the engine on soft earth or sand, without permitting any connection of the same to touch the walls or a common rock foundation, the noise and jar will not be communicated so as to cause annoyance. Prof. Elihu Thomson has installed a petroleum engine built by one of his companies, affiliating with the General Electric company, for generating electric lights for his home at Swampscott. The cost is found to be somewhat less than would be required for a steam-engine of small power, though greater than that of power derived from steam machinery of large size. It should be remembered by those desiring small power for use about a country house that every form of apparatus for furnishing the same is liable at times to special derangements and requires occasionally skilled adjustment and attention, so that annoyance, when ordinary labor is employed is sure to come sooner or later, and the selection of a motor in such a location is therefore in some respects a choice of evils. The difficulty is largely diminished if the owner himself will take pains to familiarize himself with principles and details so as to know what should be done in an emergency. If he, therefore, takes the place of a skilled engineer, the particular kind and style of motor should be one which he believes adapted for the purpose, and will therefore care for in the most efficient way. The same principles are applicable in selecting power for a small factory.

There is, however, a field for gas-engines where a supply of ordinary illuminating gas is not available. There has been in operation in England for a number of years a system in which gas is generated in a "producer" resembling that used in steel and other furnaces. The principle is that of heating a quantity of coal in a simple cylindrical vessel by admitting only a sufficient quantity of air to produce imperfect combustion. The effect is to drive off with the waste gases carbonic oxid gas, which is combustible, mingled with hydrocarbon gas if the coal is of the bituminous variety. The mixture, called "producer gas," is used in a gas-engine having the general features above described. Plants of this kind have been installed of from 25 up to 400 horse-power, and are said to operate efficiently. The economy of small gas-engines under experimental conditions is considerably greater than that obtainable with an ordinary steam-engine, a result as low as 1½ pounds of coal per indicated horse-power per hour being claimed by the manufacturers. Comparing this system with a steam-engine, it will be seen that the producer in a sense takes the place of a steam boiler, that producer gas is employed instead of steam, and that a distinctive gas-engine is required instead of a steam-engine. The number of parts necessary to do the work is therefore not varied, and the number of transformations is the same. In the steam-engine the heat of the fire is imparted to water, and the water used in the engine. In the gas-engine a part of the heat of the fuel is used to produce the gas, and the explosion of a mixture of the latter with air produces the power. The gas-engine is theoretically the more economical, simply because fixed gases are employed and operation depends largely on variations of temperature or changes of sensible heat; whereas with steam a certain quantity of latent heat must be imparted to the water to form steam, and is retained in order to maintain the water in the state of vapor when the exhaust takes place. In practice care must be taken to keep up a regular action of the producer so as to supply a uniform quality of gas. On account of the difficulty in doing this, it is believed that the economy obtained in practice is not always in excess of that of the steam-engine. The want of uniformity of the gas applies to large as well as small gas apparatus, whereas steam in large quantities can be generated and utilized continuously under conditions of maximum efficiency. It does not appear, therefore, that gas-engines and accessories can as yet compete on equal terms with large steam-engines in their present perfected condition. The wear and tear of gas-engines are, moreover, necessarily greater than those of steam-engines.

There is a future, however, for gas-engines by generating producer-gas cheaply at the mines, using even the waste coal for the purpose, and piping such gas to a long distance to operate gas engines in the way described. A modification has been proposed in England in which the gas-engines were to be operated in the immediate vicinity of the mines to generate electricity which would be conveyed to long distances for power and even heating purposes. The prospectus of this scheme showed a very large saving compared with using fuel in the ordinary way. With all due allowances for the claims of sanguine inventors and promoters, it is believed that something will be accomplished along these general lines within a reasonable period.

The advantages of the steam-engine where fuel is reasonably cheap need not be strongly urged. Its use has been extended so rapidly as to make it an important factor in the growing civilization and prosperity of mankind since the days of Watt. It can be employed anywhere that fire can be permitted, in quantities small or large ; the power is readily controlled, and the apparatus in all details easily handled by all persons of intelligence after a reasonable preliminary education and experience. It has been so tested by long practice that the details of construction for engines of the same type made by different manufacturers are substantially identical, and, though there are good and bad features among the the so-called improvements, they are of too varied and technical a nature to be treated in this article, and the services of an engineer are necessary to point them out. We can only call attention to the advantages of several distinguishing types of steam machinery. First, as to boilers : the plain vertical tubular is best for small power and particularly for semi-portable engines ; the more expensive locomotive boiler is best for self-propelling portable engines ; and the horizontal tubular boiler set in brickwork is in some respects best for general factory purposes, the sizes being fixed by the pressure to be carried and the power provided for by duplication. These boilers do so well that parties get in the way of thinking they will take care of themselves, and occasionally disastrous explosions occur.

There is therefore a growing preference for the so-called "safety" boilers, constructed principally of water tubes and connecting vessels of small size with a very large surplus strength, or, as it is called, a large "factor of safety." It is not proper in this article to attempt to discriminate between the different kinds of boiler of this type. In making a selection the question of reliability under conditions of actual and long-continued service should be considered, rather than mere differences of cost. Engines are in general distinguished as follows: "non-condensing engines," from which the steam is delivered into the atmosphere or into a low-pressure heating system; "condensing engines," from which the steam is condensed either by admitting cold water to a separate vessel or by precipitating the steam upon surfaces kept at a low temperature by circulating water, or in some cases by large volumes of air; "compound engines," in which the steam is worked serially through one or more cylinders increasing in size so as to secure expansion and reduce internal cylinder condensation. Such engines are called "simple compound engines" when there are two cylinders in series, "triple compound engines" when there are three such cylinders, and "quadruple compound engines" when there are four such cylinders, etc. In contradistinction to the above, non-compound engines are frequently called "simple engines." Engines of less than 50 horse-power are generally simple non-condensing engines. Non-condensing engines of larger size are also employed where it is difficult to obtain condensing water or where the exhaust steam can be used for the purpose of heating buildings or the various fluids required in dyeing or other manufacturing processes. Simple condensing engines are rarely made of less than 75 horse-power, and more customarily are of 125 horse-power and upward. Until quite recently they were used universally for factory purposes, single cylinders being employed up to 250 and occasionally 500 horse-power, and for larger engines two cylinders were employed, doubling the power. To provide a reasonable amount of steam for heating and other purposes about the factory, it was not uncommon to make one end of one of the cylinders non-condensing, by the use of a separate exhaust pipe quite readily arranged with engines of the Corliss type. Of late, such engines are only used where coal is comparatively cheap, and compound engines are employed in their stead, a small cylinder being arranged behind a large one for a single engine, and the same arrangement duplicated for a double engine; or, one of the cylinders of the double engine is made larger than the other and the exhaust taken across from the smaller to the larger, making what is termed a "cross-compound engine." When reasonable quantities of steam are required for various heating purposes in a factory using this kind of engine, it is customary to take the steam supply for heating from the intermediate chamber between the two cylinders, thus reducing to that extent the power of the larger cylinder only. The steam pressure employed for these three types of engines is about the same, or from 80 to 100 pounds. With the more general introduction of the compound engine the pressure has been raised to 125, 150, and 160 pounds. As it became practicable to use boilers adapted for higher pressures, a number of triple compound engines have been introduced, operated in some cases with pressures the same as for simple compound engines, but some plants have been built to use a steam pressure of 200 pounds.

The advantages of high-speed engines were pointed out by Mr. Chas. T. Porter years ago, and many engines of the Porter-Allen type have been constructed. The system was not, however, generally extended until after the experiments of the writer at the Novelty Iron Works in 1868, which showed that a high speed of revolution had the effect of reducing cylinder condensation. The adaptation to this type of engine by Mr. J. C. Hoadley, of a governor located in the fly-wheel, operating to move an eccentric transversely across the shaft and thus produce variable expansion with a single lap valve, had the effect of making these engines govern excellently and show a fair efficiency with a very simple construction. Small engines of this type are frequently run up to from 250 to 350 revolutions per minute, and, although their weight is much greater than for the same size of cylinder with ordinary engines, they still contain less material than slow-speed engines developing the same power ; so the high-speed engines can be furnished for less first cost, and have become quite popular for many purposes, particularly for small electric lighting plants. Manufacturers are frequently tempted to select this type of engine on account of its comparatively low price. Such engines are, however, made for hard service with simple details and ample clearances, and the valve gear, though efficient, does not generally give as good results as that used on slow-speed engines. The consequence is that the high-speed engines, as a rule, are not as economical as slow-speed engines. Moreover, on account of the high speed, though very carefully constructed, they generally require more careful attention. In some forms, features of automatic lubrication have largely eliminated the difficulty, but results show that, if from neglect a journal heats, the temperature rises more rapidly and is therefore more destructive on the average with a high-speed engine than with a low.

The success of high-speed engines has led to increasing the speed of forms previously known as slow-speed engines, with very advantageous results. It is found, for instance, that it is practicable to operate a Corliss engine of 42″ stroke at 100 revolutions per minute, giving a piston speed of 700 feet per minute. Similar engines of 5 feet stroke have been run up to 80 revolutions per minute, giving a piston speed of 800 feet per minute. Such engines work satisfactorily, and seem to require little more attention than larger engines developing the same power.

PLUMBING TRADE SCHOOLS AND THEIR INFLUENCE.

By E. N. G. Le Bois.

FOR reasons that are not far to seek, plumbing has not heretofore ranked high in honor among the handicrafts, and it must be admitted the plumber in the years that have gone, did much to bring upon himself the obloquy that so generally attaches to him. The perennial jokes of the newspapers that ring every conceivable change upon his jewelry, his incapacity, his cupidity, his slovenliness, and his general Ishmaelitism, tell the story of shortcomings that have been apparent at one time or another in one individual or many. His misdeeds are ever the subject of jest, but the time is not far distant when the delinquencies of his professional childhood will be kept no longer in remembrance, and he will attain to the honor and dignity that the importance of his work deserves. His case has many parallels in the rise from popular contempt of other professions which are now looked upon with high regard. Good old Dr. Browne, writing in the middle of the 17th century, spoke of the general scandal of his profession as an excuse for society's refusing him the "honorable style of a Christian"; and Le Sage but reflected the current opinion of his day when he delineated the character of that immortal charlatan, Dr. Sangrado. Or, to come a step nearer to the plumber, think how scandalized the elegant Lord Chesterfield, with his contempt for the mechanic, would have been could he have looked forward but a century and realized the status the engineering profession would attain with the names of Sir Henry Bessemer and a host of others in the nobility of his own dear native land. The changes that have affected the estimate in which certain professions are held are not due to the fickleness of public opinion, but to the advance in the professions themselves. Where in medicine quackery and ignorance ruled, and in mechanics brute force and rule of thumb, we now have the dominion of the natural sciences and the higher mathematics. In short, the education of the men who follow these callings has dignified the callings, and in like manner the education of the plumber in all that pertains to his work is already bringing the coveted reward of honor. Without the education that his work demands, the plumber must remain an ordinary manual laborer; but, with it, he is in a certain sense a sanitary engineer; and that is what he is destined to be, and will be, if he continues the upward course he is now treading.

As at present understood the sanitary engineer is one who serves in an advisory capacity; he plans and perhaps supervises in a general way the sanitation of buildings (we are not here concerned with sewerage); but the actual work of installing fixtures and running pipes is done by the plumber. As a matter of fact, the services of these engineering experts are not in general demand, and the great bulk of the plumbing throughout the country is done under the intelligent and conscientious, or ignorant and conscienceless, direction of the plumber himself. His function is therefore a most important one, and it is not doing violence to truth to say that he holds the health of the community in his hands. The physician merely cures disease; the plumber does, or should, prevent it. Not a day passes that we do not learn anew of the dangers of contaminated drinking water and of air polluted by sewer emanations. Drains must enter either into sewers or cesspools, or, as they might be termed, pest-holes; and, simple as the problem may seem, it is no easy matter to utilize these sewage receivers and at the same time completely insulate them. This is the main problem that the plumber is called upon to solve, and the more clearly he recognizes its difficulties, the more care and thought must be given to its correct solution. Education and skill alone will enable him to direct at will these deadly fluids and gases where they may do no harm, leading them away, without leakage or escape, through their proper channels. It is not necessary to exaggerate the danger of bad plumbing. The plain facts of the case are sufficiently disquieting to all who wish to live and keep in health. Persons have drunk of contaminated water and breathed the air from drains and sewers with no ill effects; but, on the other hand, who cannot recall many instances of sickness and death directly traceable to defective sanitary arrangements?

With the virtual ending of the apprentice system, under which a boy served a number of years in a shop in preparation for a journeyman, the regular training of apprentices disappeared, and a free field was opened to the ignorant and shiftless to pose as qualified journeymen with no better equipment than their own assurance. The conscientious boy could, and did, master his trade by the slow and difficult process of "picking it up" in shops where the master and the journeymen were alike indifferent to his progress; but it is no wonder that the average boy, who is in the majority the world over, shirked along for a few years in one or a dozen different shops, until, having acquired the art of wiping a joint and having perfected himself in profanity and other side lines, he accounted himself a journeyman and as such sought more remunerative employment. The absence of a proper system of training in the trade gave opportunity, furthermore, for foreign work men to push in to the exclusion of American youths, and then, too, the journeymen, fearing the overcrowding of their ranks, kept out the boys when they could, and too often hindered their education when they could not keep them out.

The late Colonel Auchmuty, whose splendid monument is the New York Trade School, realizing the miserable state of affairs that existed not only in the plumbing, but in the other manual trades as well, devoted the closing years of his life and much of his fortune to bettering the condition of his young countrymen. He saw the younger generation of Americans denied the privilege of learning trades, and resolved to furnish them the opportunity for education that the old apprenticeship system had afforded. In an address on "Trade Training" delivered before the National Association of Builders in 1889, Colonel Auchmuty said: "If then the master mechanic is no longer able to give much personal attention to his apprentice, because his time can be more profitably spent in his office than in his workshop, and, if the workshop, owing to the subdivision of labor, is no longer the best place to learn a trade, some other system of training the young mechanic must be found. That system would seem to be afforded by the trade school, where trades are taught precisely as the professions are now taught in professional schools."

Led by the New York Trade School, other schools and classes have come into being, until now there are several places where the "art and mystery" of plumbing may be conquered. It is in the east that the greatest progress has thus far been made, but whenever the west awakes to the need of this line of manual education, the liberality and magnificent enterprise of that region will, without doubt, find plentiful expression. Foreign labor has not yet encroached upon the right of the native there as it has in the older cities of the Atlantic seaboard, and, furthermore, a new country is less particular as to the quality of its domestic engineering; a Kansas farmer has not the same sanitary ideals as the Fifth avenue householder.

The New York Trade School has already been mentioned. Besides its plumbing class, which has been the most popular in point of members, the attendance during 1893 in the day and evening classes being 287 out of a total attendance at the school of 556, it has classes in bricklaying, plastering, carpentry, house painting, stone cutting, fresco painting, blacksmithing, sign painting, printing, steam and hot water fitting, tinsmithing, and roofing and cornice work. In the Department of Science and Technology of the Pratt Institute, Brooklyn, N. Y., there is a two years' course in plumbing, at the end of which an examination is held by a committee of the Journeymen Plumbers' Association of Brooklyn and certificates awarded. Should the holder afterwards apply for admission to the association, this certificate is accepted in place of the examination of like character otherwise required.

The Master Builders' Mechanical Trade School of Philadelphia, while instituted primarily for evening instruction in the building trades, such as carpentry, bricklaying, etc., has with the most satisfactory results given attention to plumbing, there being a nine months' course of three evenings per week, during which both manual and theoretical instruction are given to the students.

The three schools just mentioned are the best known places for instruction of this kind, and each is proving by its work to be of incalculable benefit to a host of ambitious young craftsmen. It should be borne in mind that these institutions are not of the eleemosynary sort, where juvenile unfortunates are taught and cared for without cost to themselves, but rather they are schools where the self-respecting young mechanic can, at a reasonable expense, attain the instruction he is searching for. Other classes there are in New York and elsewhere for instruction in plumbing, like that in the Springfield (Mass.) Christian Industrial and Technical School, the Baron de Hirsch Trade School for indigent Hebrews, and the North End Union of Boston, where the pupils are afforded the means to rise from poverty and industrial helplessness by their own efforts; and in this connection, though not of this kind, mention at least by name should be made of the trade school of the Elmira State Reformatory, where plumbing is a popular and successful course.

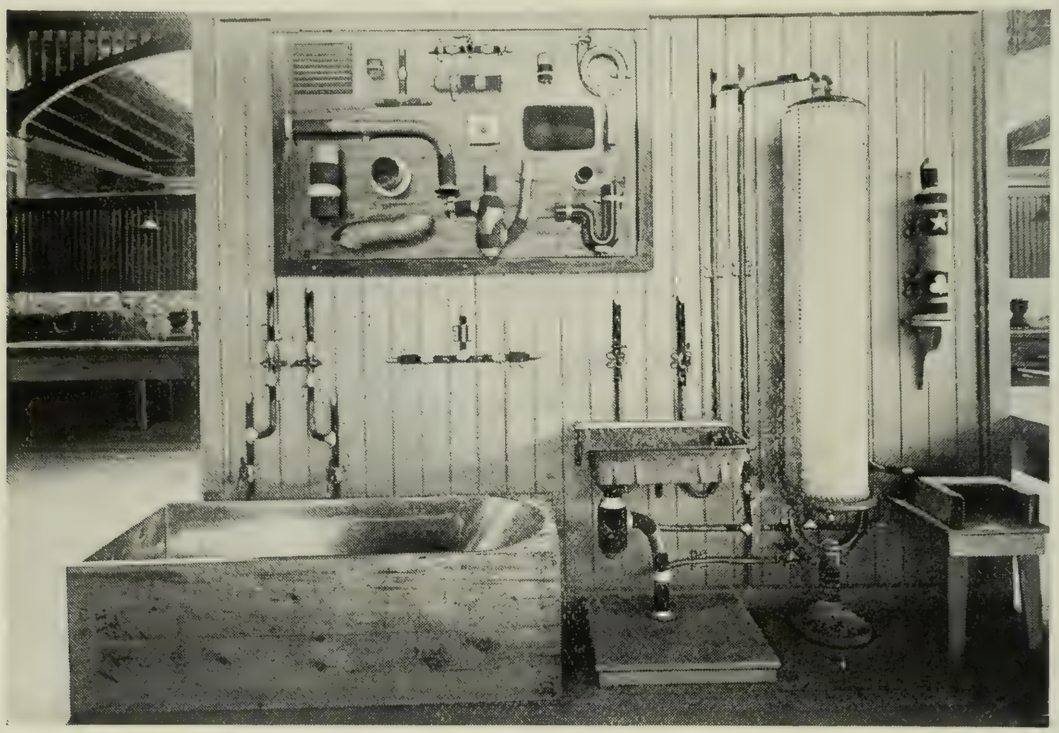
To give anything like a full account of the methods of instruction pursued at the New York Trade School, the Pratt Institute, and the Philadelphia Master Builders' School, with comparisons between the merits of the systems as they vary in these schools, is clearly unnecessary here. It will suffice to merely outline the course of instruction inaugurated by Col. Auchmuty at the first-mentioned institution. The course of plumbing at the New York Trade School includes day and evening classes; in the former, for which the charge is $40, instruction is given every day in the week for a period of four months; and in the latter, for which the fees are $14, three evenings in the week for a period of five and a half months. The day class is reserved for young men between 18 and 22 years of age, and the hours of work are from 8 o'clock in the morning till 4 o'clock in the afternoon, stopping at 2.30 P. M. on Saturdays. At present the class is limited to 120 scholars, but so popular is the course that last year a number of applicants had to be refused because of lack of accommodation. The evening class for young men between 16 and 21 years of age is divided into two sections of 75 each, who are taught on alternate evenings from 7 till 9.30 o'clock; and on Friday evenings both sections are instructed by lectures in the theoretical features of the work. The manual instruction is given in a shop specially designed and fitted up for the purpose, where the scholars, under competent instructors, are carried along from the simplest work in the manipulation of lead and solder through all the different stages of "joint wiping" up to pipe bending, fixture setting, boiler work, etc. There is also a special course in lead burning for the day class, for which extra charge is made.

The most important and difficult step in the mastery of the plumber's art is learning to wipe a joint. It is as near the one thing needful to competency in this particular calling as any single operation can be. Briefly told, it is the joining of two pieces of lead pipe by means of an elongated bulb of solder. The melted solder is poured on the abutting ends of the pipe and dexterously caught on a cloth pad ; it is then delicately manipulated over and under and around the joint as it stiffens in cooling until it finally hardens into a silvery bulb of symmetrical proportions. The operation, which is so easy in telling, means hours and days of patient labor, burns innumerable, and failure upon failure,—altogether such a self-disciplining task as would have been joyfully imposed upon the youth by the law-givers of old Sparta. But this feat in lead working must be mastered, and mastered too in all its applications. Its importance will be appreciated from the statement that of the sixteen operations that constitute the regular course of manual instruction eleven are concerned with "wiping." The scholar must learn to wipe a horizontal round joint, horizontal branch joint, upright round joint, 1/4 bend, upright branch joint, stop cock, flange, ferrule, bath plug, vertical branch, and side flange. The tasks are appointed in the order of increasing difficulty, and the young men are kept at each operation until they become proficient in it and can turn out a workmanlike job. The instructors inspect the work and give what assistance they can, but, from the nature of the case, the process of manipulating the metal successfully can only be acquired by careful and continued effort. The dexterous scholar will quickly pick up the art of handling molten metal, and is advanced accordingly ; but the clumsy novice, with no deftness of touch, finds it an all but impossible task, and the course is often ended before he has solved the entire number of material problems that are set for him to do.

For the scientific instruction, question blanks are furnished and the lecturer takes the questions in order, writing the answers on a blackboard from which the scholars copy them into their blanks. Along with the answers, the lecturer fully explains the subject with the aid of diagrams, and this plan of imparting information has been found extremely efficient. The lecture course covers water supply and drain-

THE PLUMBING CLASS AT WORK, NEW YORK TRADE SCHOOL.

HOME OF THE NEW YORK TRADE SCHOOL.



SAMPLE OF WORK AT THE PRATT INSTITUTE, BROOKLYN.

age as applied to house plumbing, some of the principal subjects being: service and waste pipes, trapping, ventilation, boilers, tanks, fixtures, and pumps. In addition to the regular instruction, the day students are taught bookkeeping and mechanical drawing, and are taken to the showrooms of dealers in plumbers' supplies to inspect the latest appliances and fixtures; they are likewise required to fill out specifications to conform to the rules of the New York Board of Health. At the expiration of the course the scholars are examined by a committee of the New York Master Plumbers' Association, and certificates are given to those entitled to them.

The opportunity to learn their trade more rapidly that the evening class offers to boys who work all day in plumbing shops, is very generally appreciated, as is proved by the fact that the great majority of students are "helpers" who thus reduce their term of service by a year and, at the same time, acquire a better grounding in the principles of their trade. On the other hand, the day class is mainly composed of young men who have no previous knowledge of this trade, but are able to give their entire time to learning it.

From this necessarily brief account of the plumbing class at the New York Trade School, it will be profitable to consider for a moment the present scope of the plumbing school and the advantages it affords. In a recent letter Mr. W. A. H. Allen, the efficient superintendent of the Master Builders' Mechanical Trade School of Philadelphia, writes as follows:

> It has been shown that evening instruction can give such knowledge that an employer will have no inducement to employ his apprentices in errand boy's work, and, to go further, some graduates, already apprentices, have stated that the information obtained in one term exceeded that of a year in the shop. In a trade like plumbing the apprentice must, of course, be occupied with whatever class of work comes to the shop, and it has happened that some of two years' standing had experience only in gas and steam fitting. Naturally, they were anxious to learn something of lead working before completing their time, and in the trade school found the opportunity they desired. . . . In the trades the great trouble is that workmen learn from each other the mechanical execution of a certain process with no knowledge of any principle to guide them if the conditions are changed. Unfortunately, also, they rather distrust books, and have no faith in science as applied to mechanical work. How many are acquainted with a general rule for obtaining the capacity of a tank of any of the usual shapes, can determine the size of a tank which will contain a given quantity of water, or find the size of several outlets of different diameter which will aggregate the area of the main? Tables are convenient, but he who knows only one way of performing a certain calculation will surely find himself often at a loss how to proceed. To many, a drawing conveys no more idea than a written page to him who cannot read, and, though they know that in the course of time they will be called on to interpret a plan, yet they usually leave such knowledge to come to them by intuition. But they appreciate its value. and applications have been received from journeymen for that part of the course reserved for the evenings devoted to theoretical instruction.

It will be seen that the function of the trade school is not alone to give manual instruction in the different processes of work, but also to instill a knowledge of principles, so that the scholar may be capable of mastering his trade in all its ramifications. A single scientific principle thoroughly comprehended will bring solutions to a hundred specific problems. For example, the hydrostatic law that the pressure of water is due to its depth independent of the size or shape of the containing vessel is of constant application in plumbing, and it is surprising how persistently the untaught mind questions this fundamental fact. That a column of water an inch in diameter will balance one of equal height twenty feet in diameter, and that a half-dozen branch pipes leading to a single closed reservoir below give no more pressure than one pipe would give, is an unceasing puzzle to the ignorant, and the plumbing papers in their correspondence departments are continually called upon to answer this question in one or another of the myriad forms in which it is propounded. That a suction pump cannot possibly lift over 34 feet is another question of similar difficulty, and the list of such questions might be indefinitely extended. Now an able lecturer, in half an hour's talk, with the help of illustrations, can so impress upon the scholars the principles governing these cases that, however the question may arise in after practical experience, it will never occasion the slightest doubt in mind or hesitancy in action.

Another thing to bear in mind in connection with the theoretical instruction the trade schools afford is that manual dexterity in the working of lead will be of less account in the future than it has been in the past. Much high-class plumbing nowadays involves no lead work at all, and the use of iron and brass pipe, together with the extensive variety of fixtures and fittings on the market, relieves the plumber of a great deal of special labor peculiar to his trade. So far, therefore, as the manual work is concerned, he will tend to become merely a good general mechanic, but well-versed in sanitary science ; and more and more emphasis will be laid upon the latter qualification.

That the plumbing trade schools, as at present conducted, do not fulfill to the letter all that was prophesied of them will hardly be denied, but that they do fulfill in a large measure the promise of their beginning is a fact beyond dispute. Apart from all outside influences, such as the opposition of trade unions that wish to keep down the number of skilled mechanics in their calling, there are other difficulties in the way of perfect success. The course in the trade school is necessarily short, and also, from the nature of the case, much of the scholar's labor is expended upon mere school exercises ; and such work, in spite of all that may be said to the contrary, does not appeal to the scholar and stimulate him in the way that work to some directly practical end, for which he will be paid, appeals and stimulates. He will perhaps master the principles of his work more thoroughly in the school than in the shop, but the finished school exercise shows the touch of the amateur more evidently than the corresponding operation performed under the less friendly eye of a wage-paying employer.

Then, too, the large number of young men in the classes prevents the continual supervision of the instructor, and he cannot, therefore,

THE PLUMBING CLASS AT WORK, MECHANICAL TRADE SCHOOLS, PHILADELPHIA.

correct each misapplied effort and faulty manipulation. Finally, the young men themselves, though far more conscientious than a similar number of students in any college, will, at times, with the nonchalance of youth, evade their duty, and even the fact that they are paying for the instruction with their own hard earned dollars, or out of the scanty savings of a parent, will not altogether overcome the careless spirit of indolence. To find a class of scholars, even in a trade school, devoted to their work without cessation, and free from every trace of desire to shirk, would be to find, not a class of flesh and blood young men, but a company of apprentice angels who had strayed away from heaven. But it is a thankless task to point out the practical deficiencies of schemes of instruction offered by the trade schools. These institutions are all doing a noble work, and the increasing number of better educated mechanics that they are yearly sending forth will do much to advance the status of the plumbing and other manual trades.

PRACTICAL LABORATORY TRAINING FOR METALLURGISTS.

By Professor Robert H. Richards.

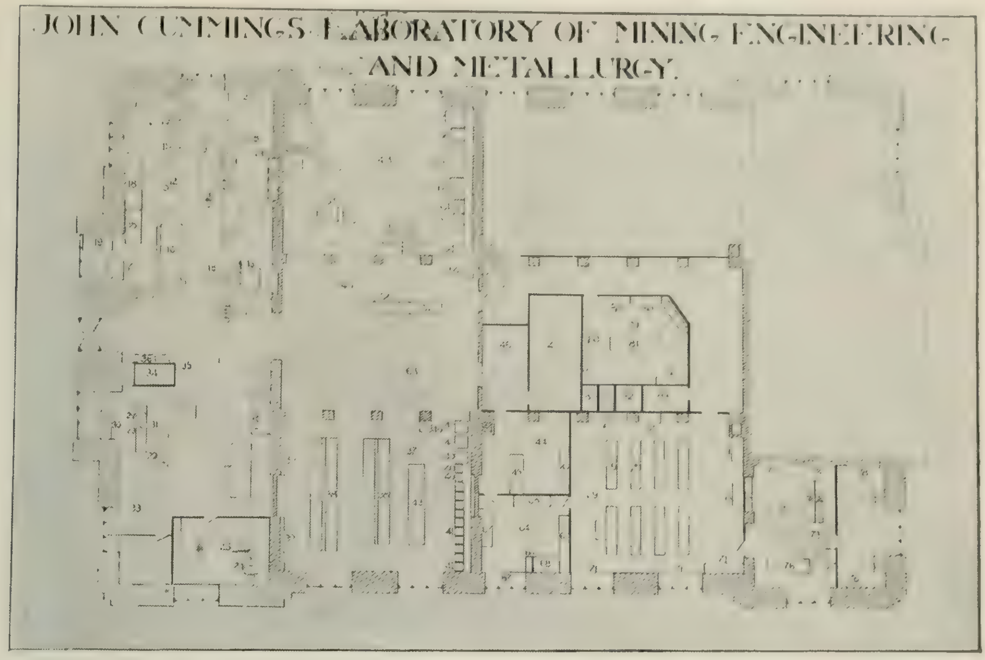
THE marked change in methods in education during the past thirty years is nowhere more plainly seen than in the light in which laboratory instruction of any kind is regarded.

If the question had been asked in 1865, "Is it necessary to have laboratories of ore-dressing and metallurgy in a school of mining engineering and metallurgy?" it would have been necessary to defend with all the arguments that could be produced the position that teaching by experience from contact with things was a powerful step forward in education.

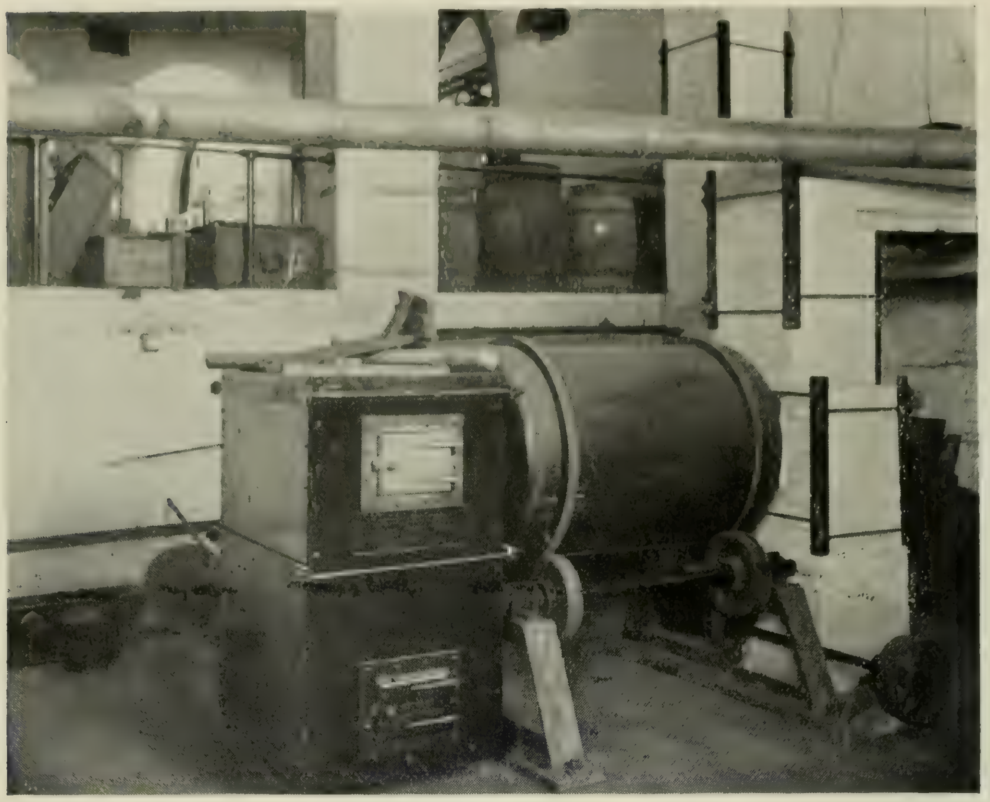
Now, however, the development of the modern experimental method of teaching has been carried so far and with such success that defense is unnecessary. In the grammar and high schools manual training and drawing give a reality to arithmetic, algebra, and geometry. In chemistry and physics experimental laboratories clear up the meaning of the text-books. In literature, language, history, and mathematics the use of charts and diagrams makes clear the meaning of the books. In civil, mechanical, and electrical engineering field practice, machine work, testing power, economy, and efficiency, together with drawing, round out the text-book work with the experience necessary for a full understanding of it. To go farther, some of the strongest schools of mining and metallurgy in the country have become so largely through the development of field work and summer schools and of laboratories of mining and metallurgy.

In comparing the three great engineering professions, civil, mechanical, and mining engineering, it will be seen that the civil engineer deals with bridges, roofs, dams, aqueducts, and reservoirs; all of which are fixed structures and mostly with fixed load. The conditions are disturbed by trains, heavy snows and winds, floods, frosts, and thaws to a certain extent, but it does not appear difficult to obtain a factor of safety which will ensure protection from accident. This factor of safety is comparatively small. The mechanical engineer deals with machines which, besides the statical forces, have to resist inertia, momentum, and impact. Here the range of possibilities is much greater; hence the factor of safety has to be much larger than with the structures of the civil engineer. The mining engineer, on the other hand, has to deal with the uncertainty of the mine roofs, mine water, and, in

ROGERS BUILDING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, METALLURGICAL LABORATORY IN BASEMENT.


JOHN CUMMINGS LABORATORY OF MINING ENGINEERING AND METALLURGY.

1. Milling Room.
2. Blake Crusher.
3. Cornish Rolls.
4. Gates Crusher.
5. Sample Grinder.
6. Iron Sampling-Floor.
7. Cornish Automatic Feeder.
8. Trough Automatic Feeder.
9. Spitz Lutte.
10. Coarse Collom Jig.
11. Fine Collom Jig.
12. Slime Table.
13. Hendy Feeder.
14. California Stamps.
15. Amalgamated Plates.
16. Frue Vanner.
17. Jig with Moving Sieve.
18. Water Tanks.
19. Steam Drying Tables.
20. Sample Bucking Plates, etc.
21. Sampling Table.
22. Ore Bins.
23. Pounding Block.
24. Upright Engine.
25. Dynamo 50v x 50a.
26. Dynamo 2v x 50a.
27. Depositing Table.
28. Leaching Tubs.
29. Larger Amalgamating Pans.
30. Smaller Amalgamating Pans.
31. Settler.
32. Tank.
33. Space to grow in.
34. Store Room.
35. Blacksmith's Drilling Machine.
36.1. Carpenter's Bench.
36.2. Double Ball Grinding Mill.
37. Assaying Room.
38. Students' Desks.
39. Ore Balances.
40. Muffle Furnaces.
41. Crucible Furnaces.
42. Great Stack.
43. Iron Table.
44. Balance Room.
45. Fine Balances.
46. Store Room.
47. Store Room.
48. Furnace Room.
49. Blacksmith Forge.
50. Anvil.
51. Blacksmith Table.
52. Water Jacket Furnace.
53. Furnace Ore Bins.
54. Brückner Roasting Cylinder.
55. Copper Refining Furnace.
56. Larger Calcinining Reverberatory.
57. Roasting Kiln.
58. Lead Kettle.
59. Larger Cupelling Furnace.
60. Smaller Calcining Reverberatory.
61. Smaller Cupelling Furnace.
62. Pot Furnaces.
63. Space to grow.
64. Professors' Laboratory.
65. Table for Electrolytic Work.
66. Experimental Spitzlutte.
67. Chemical Desks.
68. Hood.
69. Blowpipe Room.
70. Tables.
71. Cases for Apparatus, etc.
72. Sink.
73. Library.
74. Bookcase.
75. Space to grow.
76. Table.
77. Professors' Desks.
78. Lithographic Notes, etc.
79. Toilet Room.
80. Lockers.
81. Basins.
82. Closets.
83. Professors' Room.



BRUCKNER ROASTING FURNACE.

fact, the very life of the mine—all of which call for the development of judgment to a marked degree. Metaphorically speaking, we may say that his formula is mostly factor of safety, and that the factor of safety is determined by his judgment.

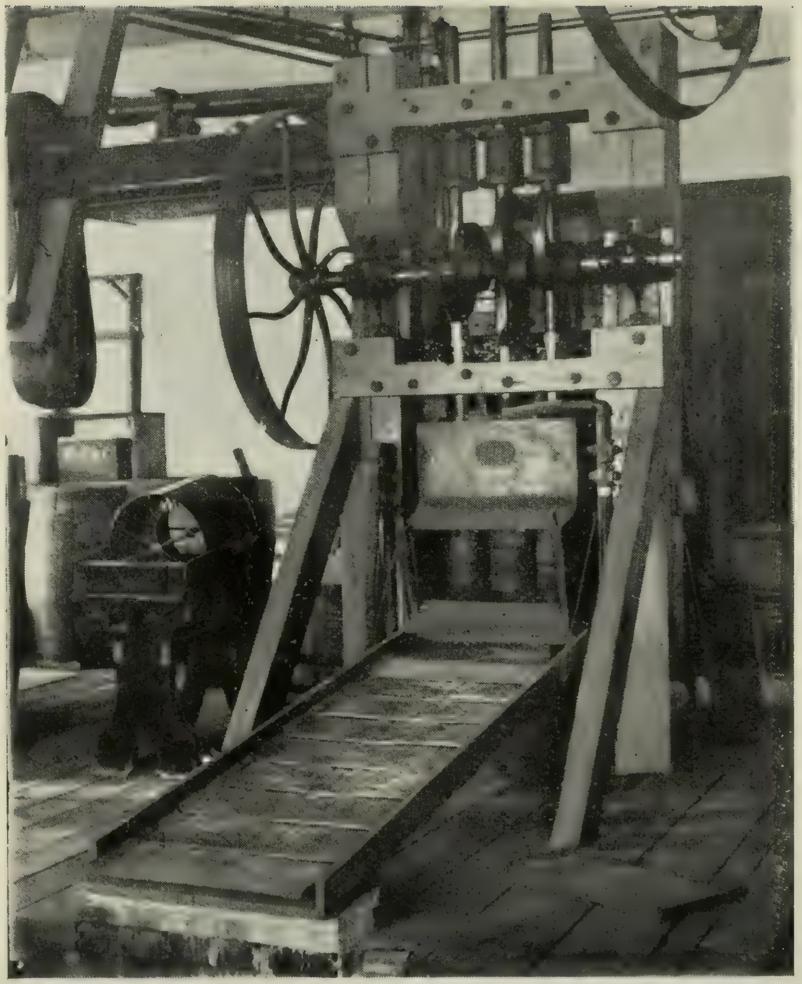
How much more important does it seem, then, that the young mining engineer and metallurgist should early begin to learn by experience from actual professional work, not only in order that he may gain the advantage of interpreting his text-books intelligently, but also to store up that fund of experience upon which his active professional work must so largely depend.

A school of mining and metallurgy, then, needs a laboratory for ore-dressing and one for smelting and other reduction processes to give the young engineer a good start in acquiring from his own personal experience the principles involved in his profession. He can make this beginning much better with guidance than without it. Hence it is better for him to become accustomed to machines and processes in the school than after he leaves it. Again, experience acquired during the school course reacts upon the lectures, which, as a result, immediately cease to be abstract dissertations and become concrete acquisitions.

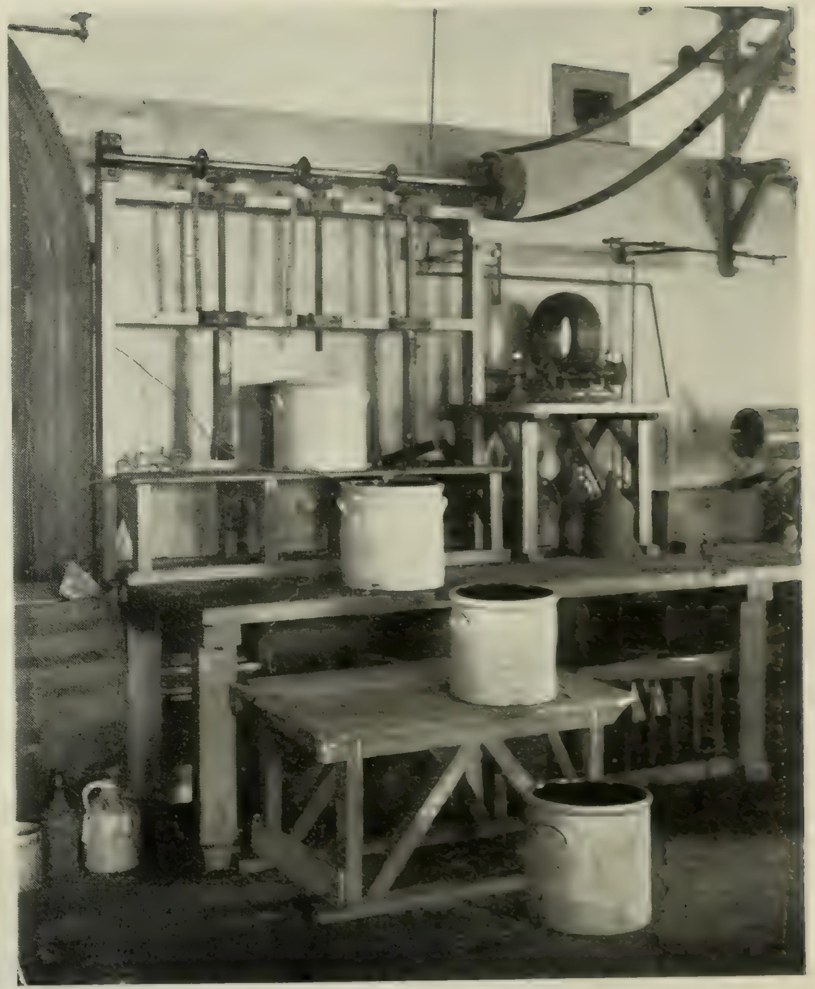
The laboratory should contain apparatus which it is practicable to use for treatment of ores. The ore-dressing, roasting, amalgamation, lixiviation, smelting, and refining of the ores of gold, silver, copper, and lead furnish the desired field. Mining operations are impracticable: prospecting, sinking, drifting, stoping, hoisting, can only be taken as field work; they can none of them be adapted for school laboratory work. The metallurgy of iron and steel, including smelting, puddling, Bessemerizing, open-hearth and crucible steel, has not been adopted, owing to the magnitude of the quantity of material and the time, labor, and cost incurred. It is not probable that any of them will be adopted in the school, unless possibly the last mentioned. In fact, they are not needed, as the young man can study the principles of metallurgy just as well with the copper, lead, silver, and gold ores. But the fact that it is only principles which are being taught in the laboratory, and not practical details, cannot be too strongly emphasized. It is true that principles are well taught by the use of correct practice. But practice is an incident only, and one on which the student cannot afford to spend his school time.

A strong point in favor of laboratory training is the opportunity that is afforded to learn by making mistakes. For example, if a student in roasting a gold ore preparatory to gas chlorination fails to

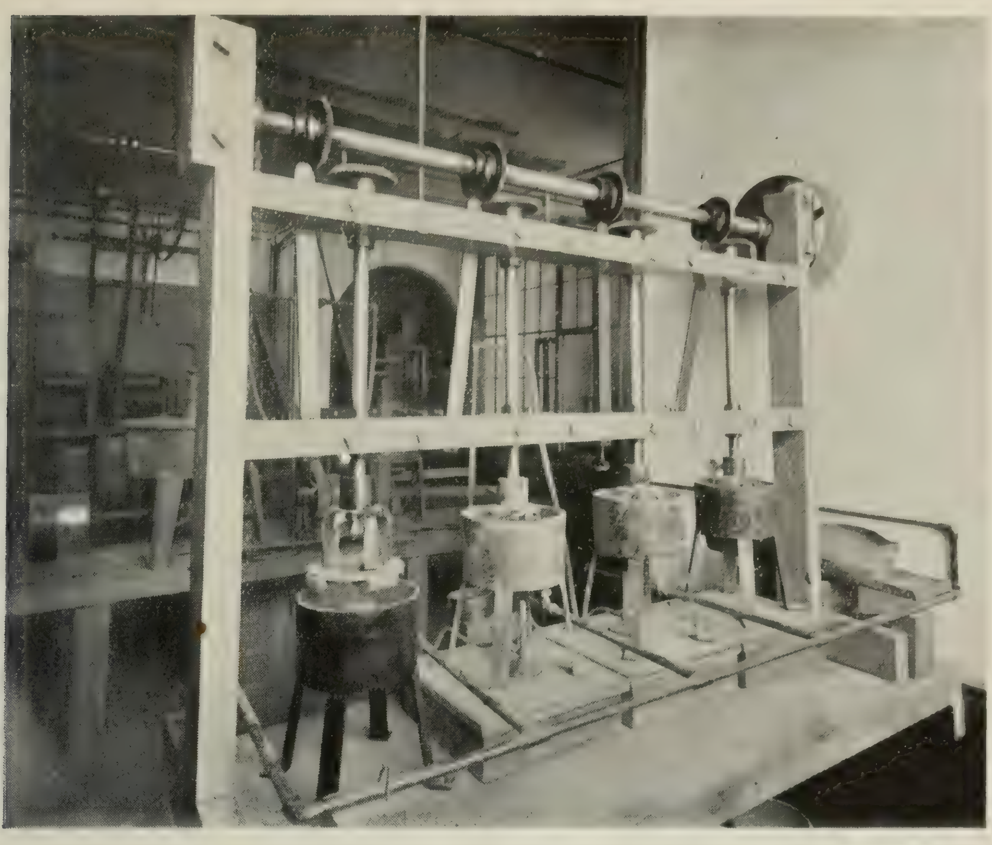
COPPER REFINING FURNACE AND ROASTING FURNACE.



STAMP BATTERY AND AMALGAMATED PLATES.



LEACHING TUBS ARRANGED FOR MECHANICAL STIRRING.



SET OF SMALL AMALGAMATING PANS.

read his instructions and puts salt in with the ore at the beginning of the roasting, he may find, when he takes account of stock, that from twenty to forty per cent. of his gold has disappeared up the chimney. The results of the test are:

a. A loss of gold amounting to $1.00 or less.

b. The student has learned that gold chloride is volatile.

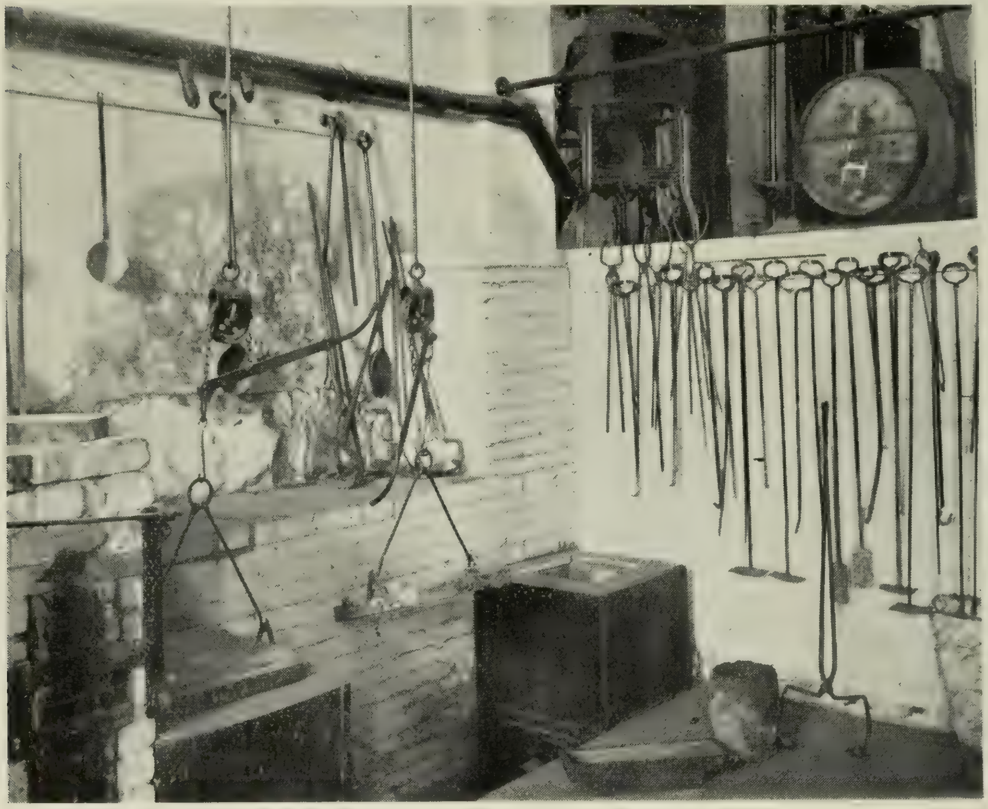
c. The student has learned that, if he would succeed at anything, he must get all the known facts about it before beginning the test.

Which of these three results is of greatest value to the student?

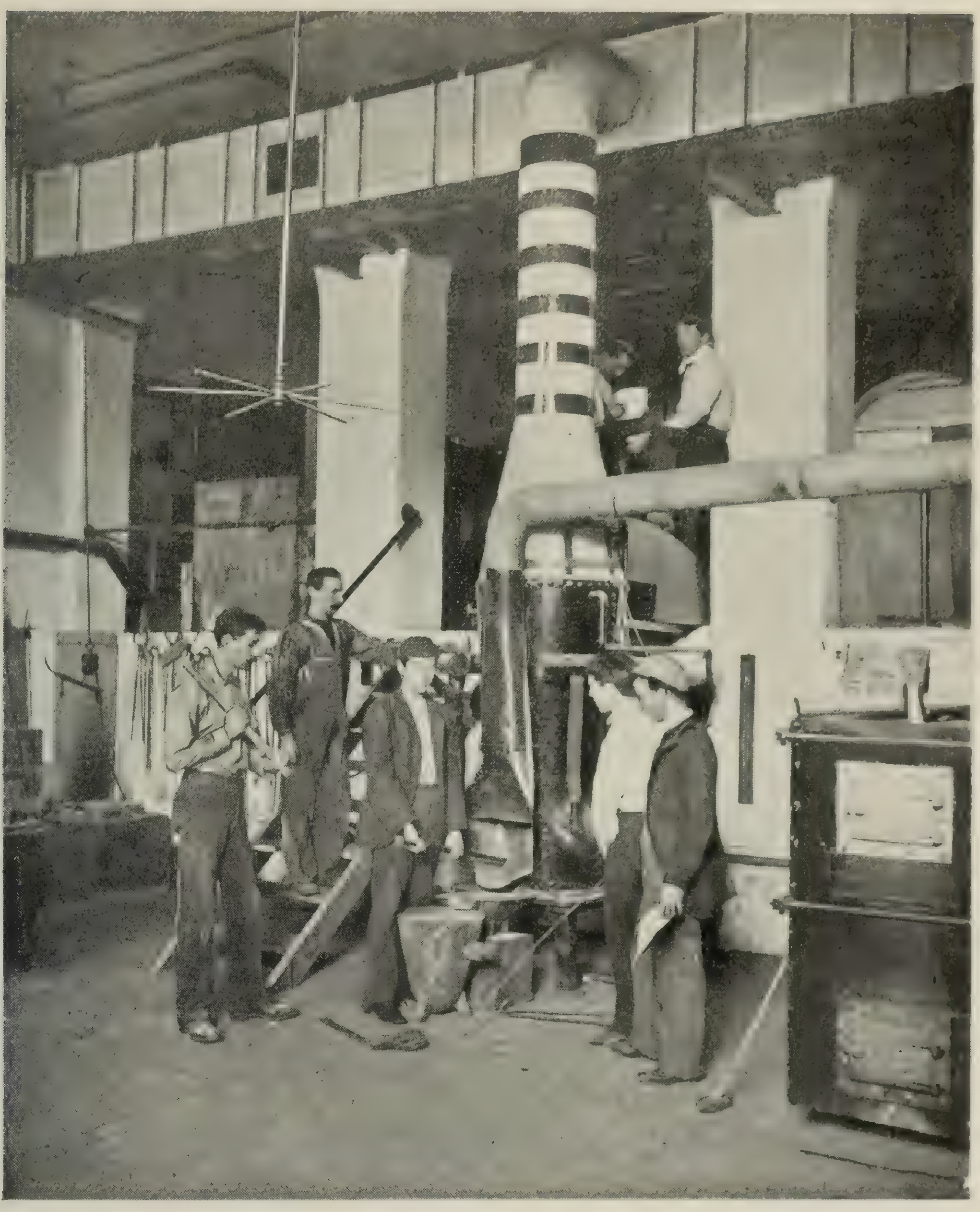
Undoubtedly the last is by far the greatest, because it reaches into all metallurgy, while the first two are but isolated facts. But one may say, "The latter is not metallurgy at all; it is common sense." The reply is that we must make the man before we can make the metallurgist. We must cultivate common sense in metallurgy by every possible means, and that is the object of the laboratory.

It has sometimes been urged that a laboratory of this sort ought to settle many important metallurgical questions: for example, what is the best rate of fall and height of discharge of stamps for the maximum amount crushed for the power employed? It should be able to settle such vexed metallurgical questions, but this goal will not be reached largely with undergraduate work. The moment the experiments are so guarded that the student cannot make his mistakes and gain his experience, the advantage of the laboratory to him is largely curtailed. The mode in which advanced metallurgical experiments can be obtained is through the return to the school of older, more mature men who come to the laboratory with the sole purpose of working out some problem. To these the laboratory should always be open, and their work should prove of the highest value to the metallurgical world.

In order that a process may be suitable for adoption in a mining and metallurgical laboratory, it must teach some ore-dressing or metallurgical facts and give some experience. The student must have an opportunity to exercise his judgment; first in selecting his process, then in operating the process chosen. Therefore, it is well that there be alternative processes. An illustration may be taken from work with a slime table. The questions arise: shall clean heads be made and the tails be treated again; or, shall there be clean tails and the heads be treated over; or, shall there be clean heads and tails with a middling product? These same questions again arise in regard to smelting for the greatest quantity of clean metal and clean slag: shall the lead be held in the crucible of the furnace and tapped



FURNACES FOR POT MELTING, WITH TRAVELING LIFT FOR COVERS.

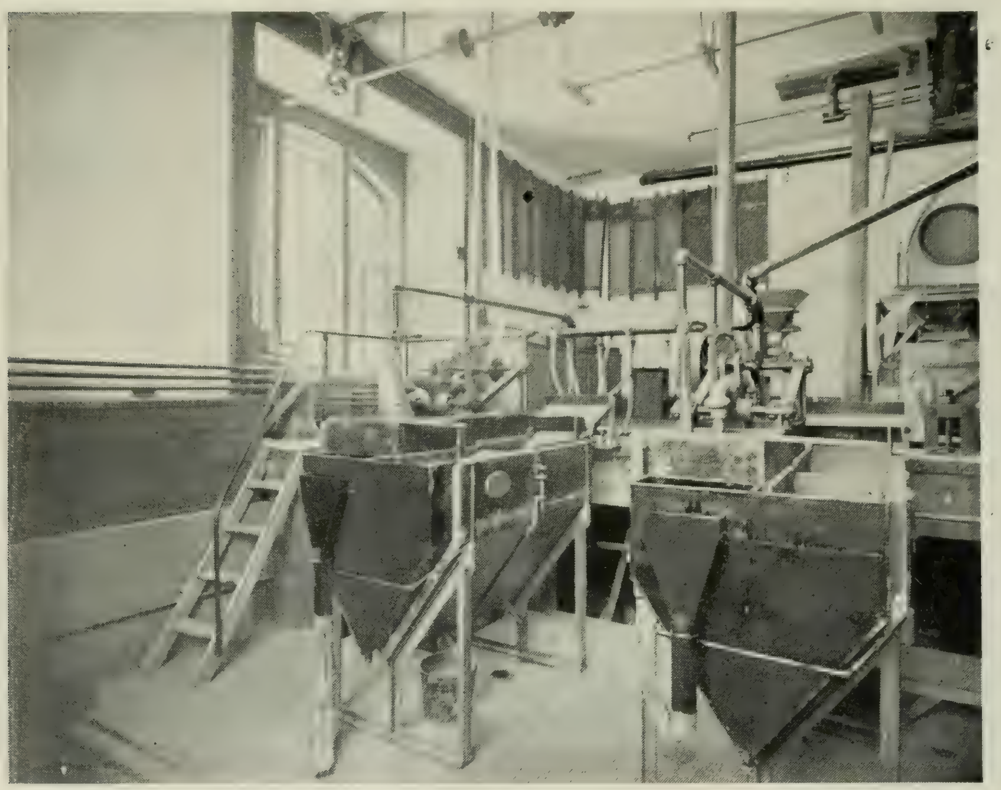


WATER-JACKET FURNACE FOR SMELTING LEAD AND COPPER ORES.

out periodically ; shall a lead well be used ; shall a fore hearth be used : or shall the lead, matte, and slag be tapped out clean and all together at every tap ?

Finally the student should have means to test his results in order that he not only may see if his selection of the process was good, but also may form his conclusions in regard to operating the process. If smelting is to be done, the student should analyze his materials, calculate his charge, make his smelt, and analyze his slag, in order that he may ascertain how nearly his results agree with the plan he made. He should then take a complete account of stock, and account in each case for every bit of the valuable metal lost. This careful account of stock is one of the most valuable parts of the student's training. He sees how much depends upon slight variation in process and upon the careful handling of material when upon the sum total of these items rests the difference between profit and loss. Where work is done upon a small scale,—for example, as in amalgamation,—the student may try a series of experiments in search for the conditions yielding the highest rate of extraction. Wherever possible, highest net economy or highest extraction should be brought into the work.

The scale upon which laboratory work should be done will be governed by several considerations. It must be large enough to give some real experience approaching practice with both the physical and chemical forces at issue, but not so large as to tire out and discourage the student by the sheer effort of the mechanical handling of the ore and products. Other considerations—such as the distance from the mines and the cost of purchasing and freighting the ore (in case it is not given in return for results)—will tend toward a solution of the question of the amount to be handled. This will also determine the size of the apparatus to be selected. An instance will perhaps best show the manner of deciding this point. A California gold stamp battery will crush



A PAIR OF 2-SIEVE COLLOM JIGS.

CUPELLING FURNACE—STUDENTS WATCHING FOR THE "BLICK."

from ten to fifteen tons in twenty-four hours with an average of perhaps twelve tons. It would then crush one thousand pounds of gold quartz in one hour. If, for reasons previously given, one thousand pounds of gold ore was the quantity found to be the most desirable for treatment, then the full-sized battery would stamp it so quickly that there would be very little experience gained by the use of it. A far better proportion would be 250-pound stamps and three of them in the one battery. Such a set of stamps would take seven to eight hours to crush the one thousand pounds of gold ore, and would give a day of good experience to the student in charge, as well as to the members of his class. In like manner the size of all the machines should be selected with reference to their speed of treatment and the quantity to be treated.

The student's work will naturally divide itself into (*a*) the period of preparation, (*b*) the period of experimenting, and (*c*) that of cleaning up and taking account of stock. Each member of a class may be assigned his own complete metallurgical process. During the first and last periods above mentioned he will naturally work alone and without the help of his classmates. But when the ore treatment is to be done, then the whole class will be called in to render assistance. In this way all will gain experience from working the machines or furnaces.

Another advantage which the student derives from his laboratory work is the ease with which he can go from the laboratory into the smelting works or mills. The transition is made without any great plunge. He has, as it were, been there already. This saves his self-respect with the men, and brings him into a condition much nearer to usefulness at the start than any attainable by other known systems.

The director of a laboratory must have both the knowledge and the skill to do all the kinds of work in the curriculum, and he must have had experience enough in metallurgy to help the student to reach wise decisions as to his methods and just conclusions as to his results, that he may get the most out of his work, and avoid going off on too many fool's errands. The director must make the interest of his students his first care, and not allow the advancement of science or of business interests to interfere in any way with the highest development of the student.

The laboratory must be considered simply as a means to an end, and that end is the development of the student's power to investigate and to execute.

[The illustrations accompanying Professor Richards' article show the building containing the metallurgical laboratory of the Massachusetts Institute of Technology, the apportionment of space, and the more important items of the plant.—EDITOR.]

OPERATING MACHINE TOOLS BY ELECTRICITY.

By George Richmond.

THE principal office of the machine tool being to remove surplus metal, it would seem that a direct relation might be established between the weight of cuttings produced and the work done by the driving engine. Experiments on a variety of tools have shown that 1 horse-power applied directly is sufficient to remove about 40 pounds of cast iron, 33 pounds of wrought iron, and 23 pounds of steel.

Any attempt to utilize these results in estimating the power of the engine would require the introduction of an efficiency factor, so small and variable in amount as to reduce the operation to that of a mere guess.

It is well, indeed, to keep this ultimate ratio in mind, for the additional work expended is that alone which is capable of reduction, and it is so enormous in amount as to leave room for the exercise of judgment in various directions. Something may be effected by the discretion of the foreman in choosing the proper tool for doing the work, and by the workman in keeping his tools in proper condition for cutting off the maximum amount with a given power, and still more in keeping the machine in easy running order ; but there remains a large amount of work expended by the engine which is unaccounted for, either by the heap of cuttings or the friction of the tool itself.

The following table* gives some actual data on this subject, from which we see that the lost work varies from 15 to 80 per cent., giving an average in the ten shops of 38.6 per cent. It is extremely difficult to make these comparisons in such a manner as to draw fair conclusions, for in the first place it is obvious that the larger the extent of the establishment and the greater the area over which the power is distributed, the larger will be the proportion of lost work. The engine is rarely, if ever, located with a view to driving the whole of the machinery with which it is ultimately connected to the best advantage as regards transmission. Such a position would theoretically be found by a process similar to that of finding the center of gravity, so that the engine might transmit the same power in every direction. As it is, the addition of extra machinery at a point necessarily very remote from the engine may involve not only the work required to drive it,

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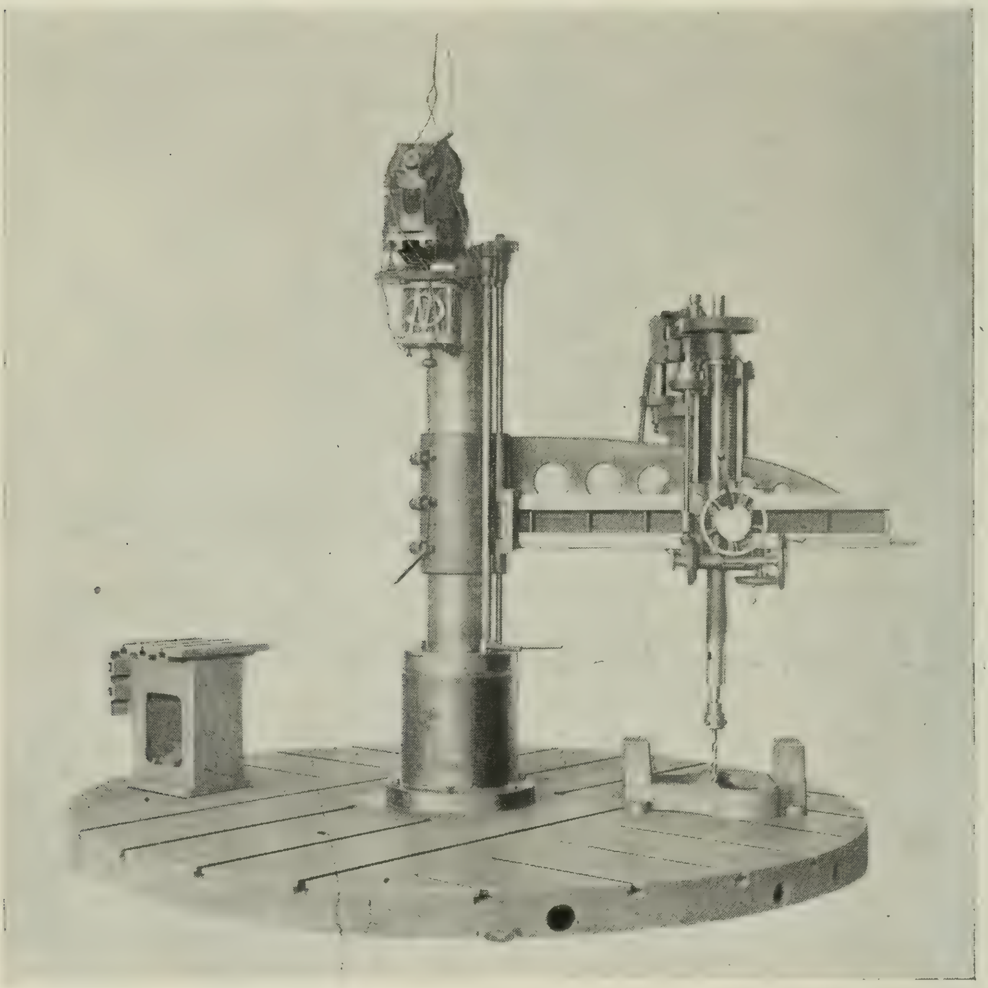
* From Dynamometers and Measurement of Power. Prof. J. J. Flather.

		HORSE POWER.		
Name of Firm.	Nature of Work.	Total.	To drive Shafting.	Per cent. to drive Shafting.
J. A. Fay & Co.	Wood working machinery.	100	15	.15
Union Iron Works	Engines, mining machinery	400	95	.23
Frontier Iron & Brass Works.	Marine engines, etc.	25	8	.32
Baldwin Locomotive Works. .	Locomotives.	2500	2000	.80
W. Sellers & Co. (one dep't.)	Heavy machinery.	102.45	40.89	.40
Pond Machine Tool Co.	Machine-tools.	180	75	.41
Yale & Towne Co.	Cranes and locks.	135.05	66.81	.49
Ferracute Machine Co.	Presses and dies.	35	11	.31
Bridgeport Forge Co.	Heavy forgings.	150	75	.50
Hartford Machine Screw Co.	Machine screws	400	300	.25

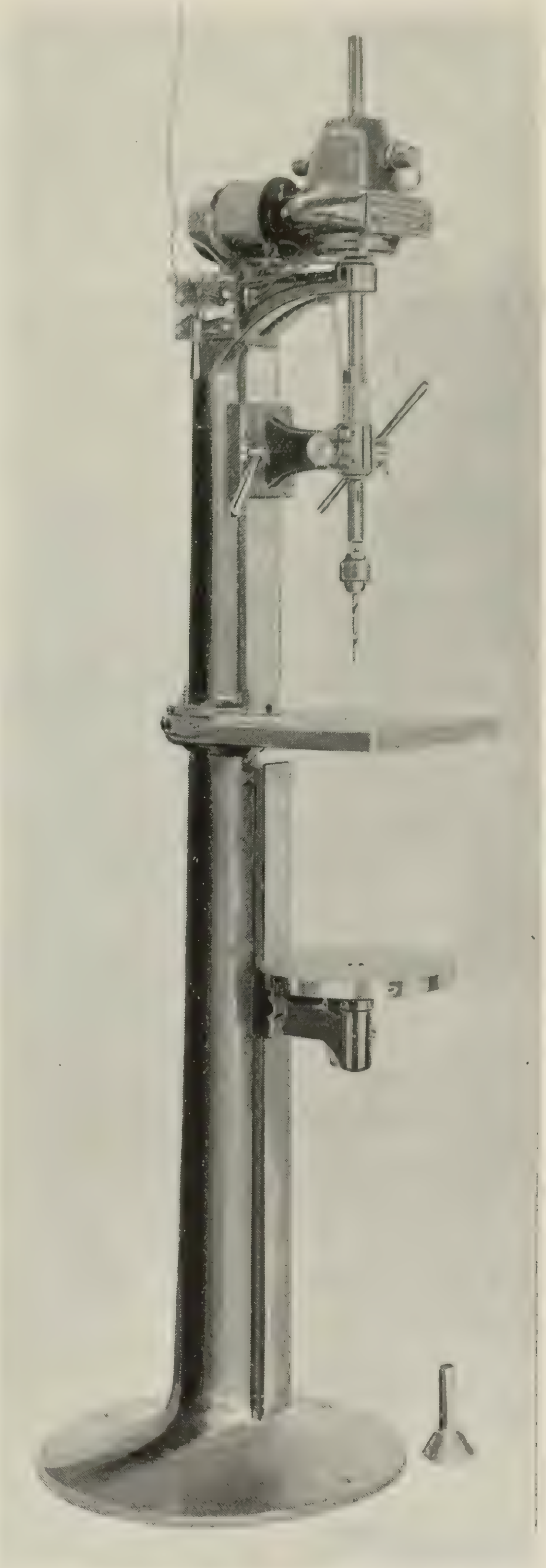


A CROCKER-WHEELER MOTOR OPERATING A RADIAL DRILL PRESS.

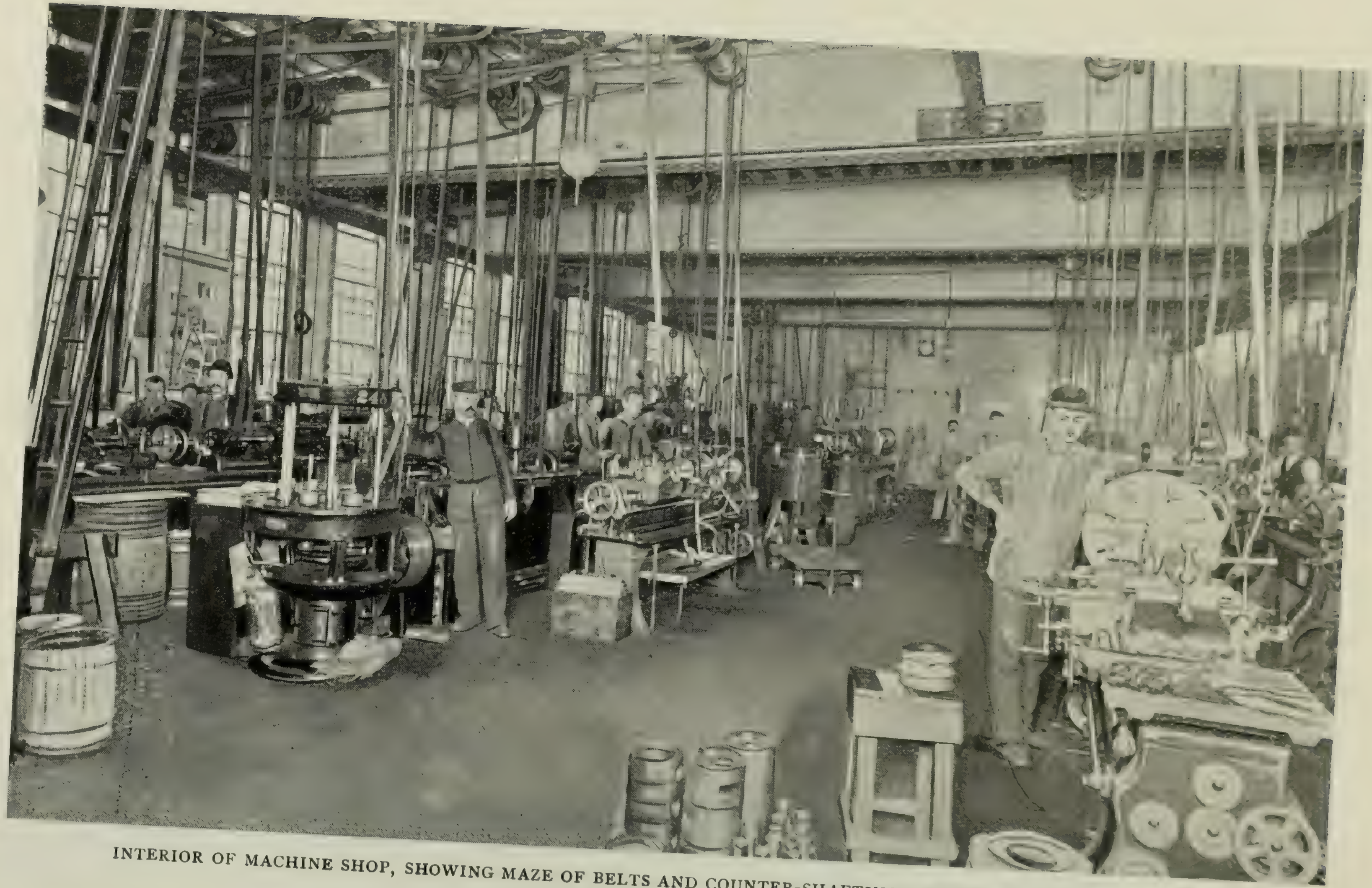
but a strengthening of the main shafting and consequently additional friction along the whole line of transmission. Moreover, the relative continuity of running is a factor which must be taken into account, for the lost work expended in transmission is the same whether the tool is run one hour or ten.

The cure for this, proposed by the electrical engineer, is, in its most radical form, to attach a motor to each machine-tool. In even the largest and most straggling establishments the cost in the leads for transmission to the machine is then insignificant. The power consumed is strictly proportional to the work done, and we are now brought to a point at which we can make a comparison between the weight of the cuttings and the reading of the Watt meter. We should not indeed get a very constant ratio, but we should obtain some valuable information as to the efficient running of the machine as such, and the man handling it. A less radical solution is to group a number of machines around a motor admitting of an infinite variety of combinations,—from that of two or three machines to that of all those on the same floor or in the same shop.

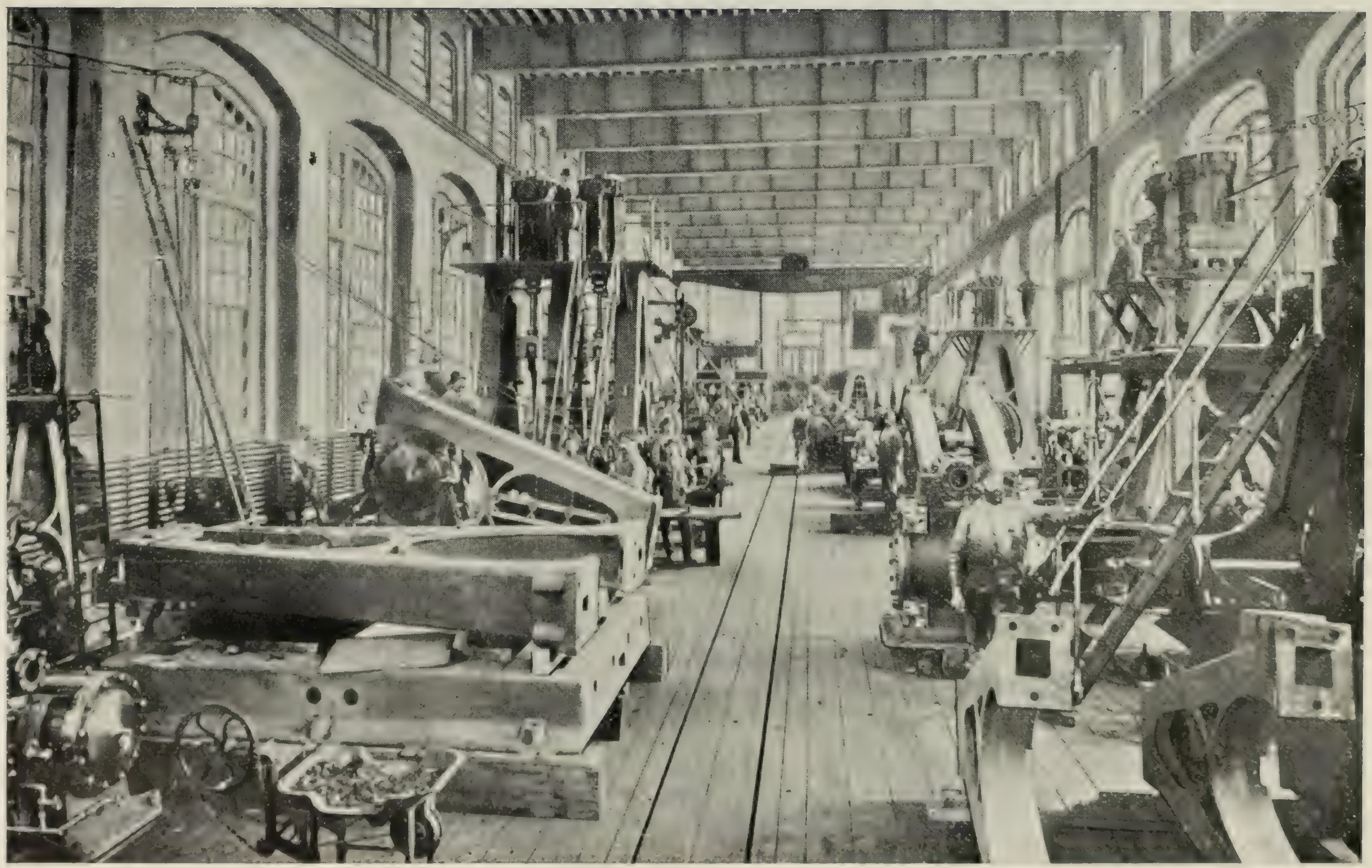
The first solution is that



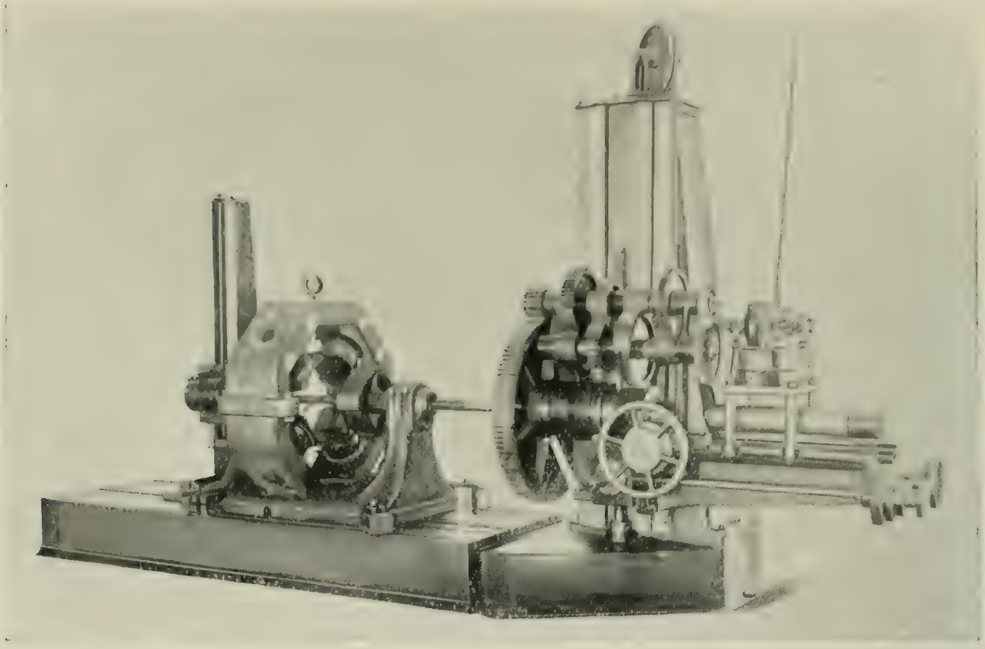
VARIABLE SPEED ELECTRIC DRILL PRESS.



INTERIOR OF MACHINE SHOP, SHOWING MAZE OF BELTS AND COUNTER-SHAFTING AVOIDED IN ELECTRIC DRIVING.

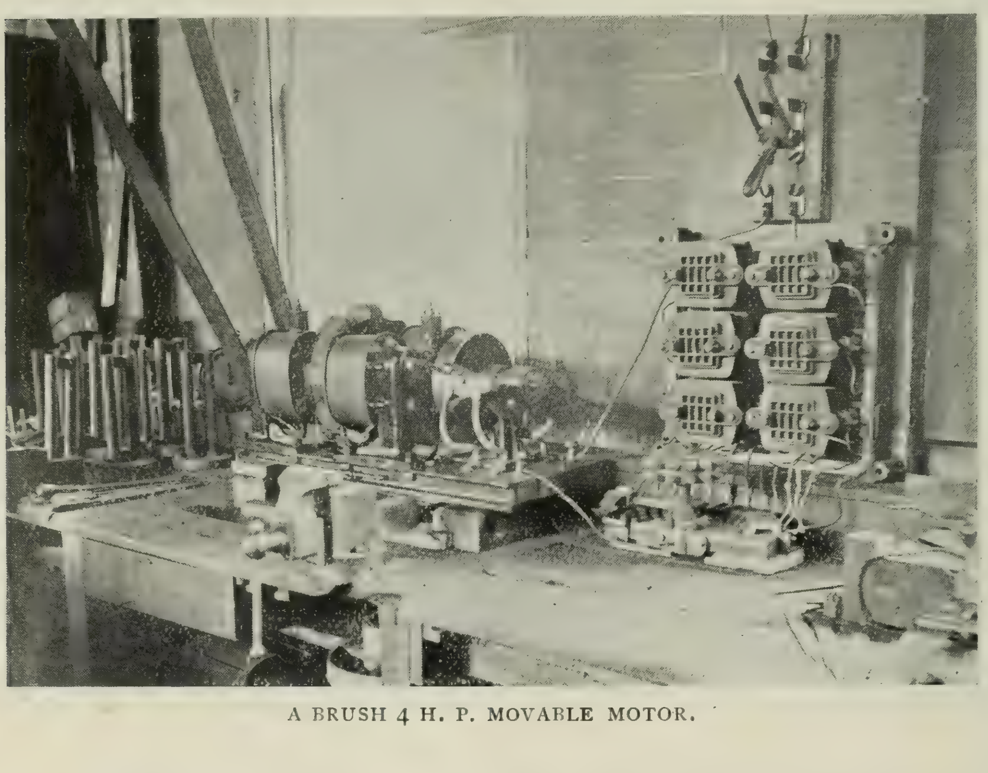


ERECTING DEPARTMENT, DE LA VERGNE REFRIGERATING MACHINE CO., SHOWING CLEAR HEADWAY FOR TRAVELING CRANE.

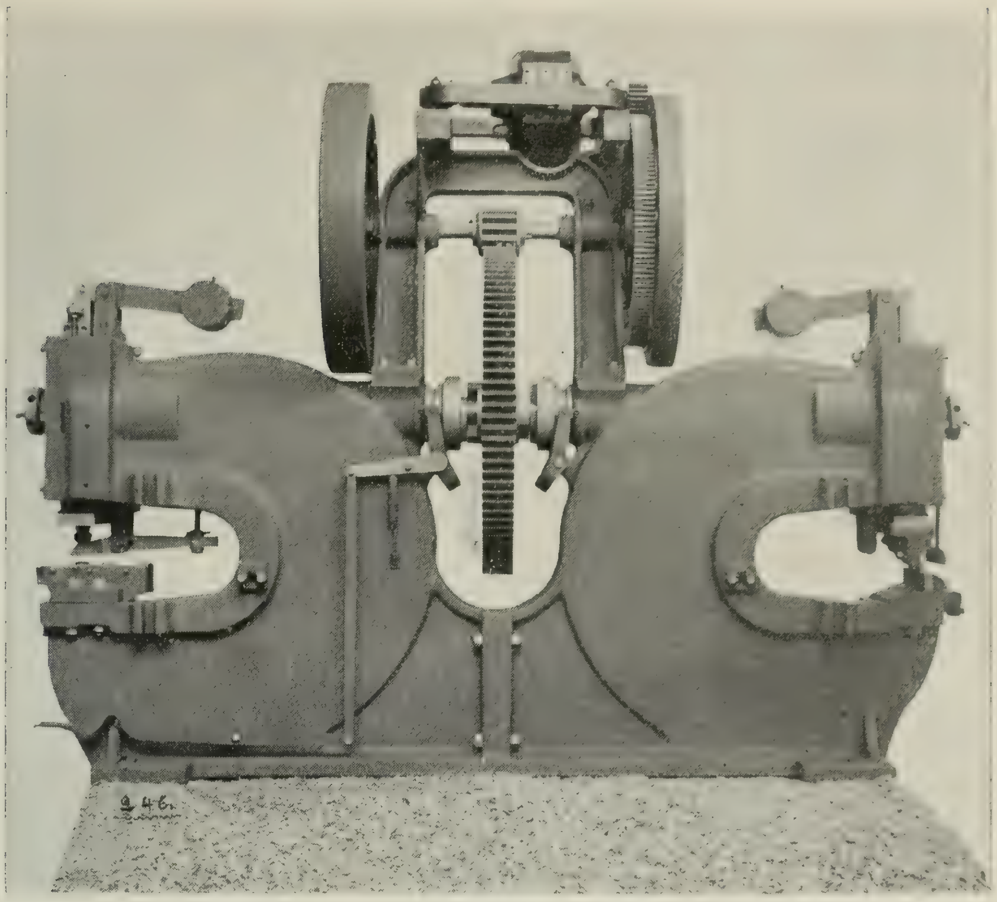


IO-TON BORING MILL, CHANGE GEARING; POWER SUPPLIED THROUGH LAMP CORD TO I H. P. MOTOR ON BORING HEAD.

which appeals most strongly to the imagination, and, without being carried away by the somewhat rhetorical enthusiasm of the motor manufacturer, the picture of a shop devoid of light-obstructing belting and belt shifters, oil-dripping hangers, and perverse main shafts is an



A BRUSH 4 H. P. MOVABLE MOTOR.

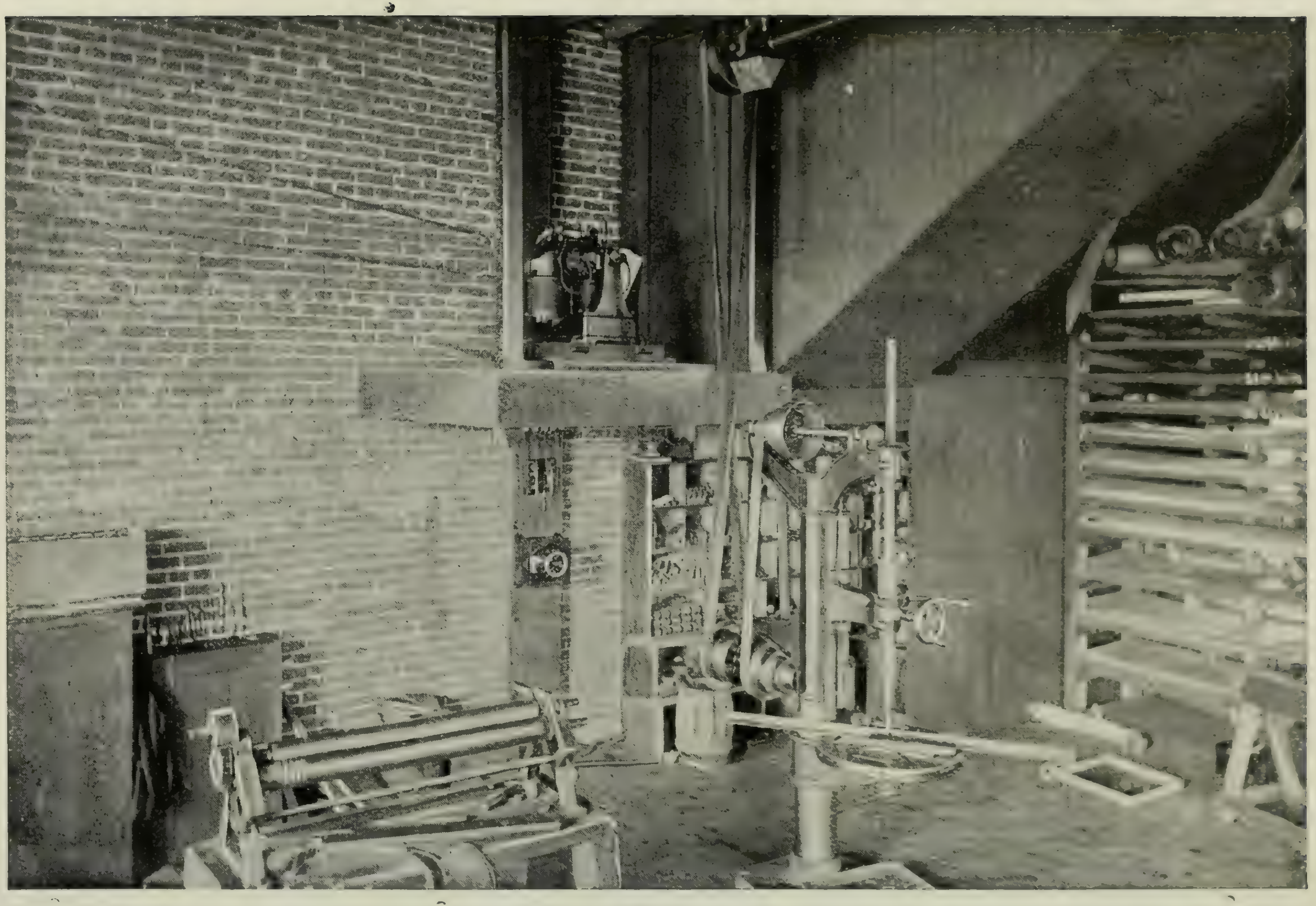


A LONG AND ALLSTATTER PUNCH DRIVEN BY ELECTRICITY.

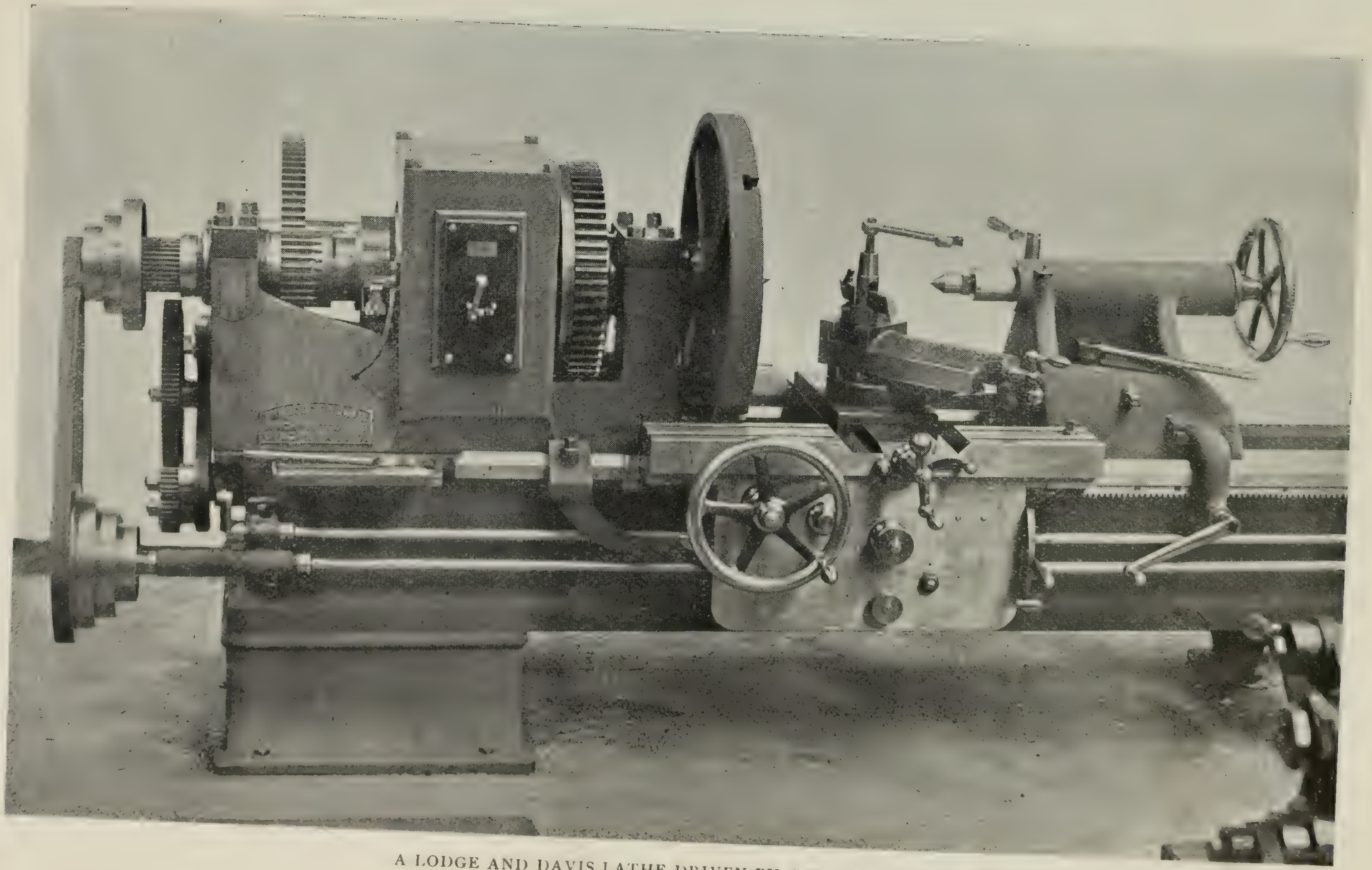
inviting one. We are even willing to admit that, when light traveling cranes run over all the tools, the workman will whip the work into and out of the lathe with incredible promptness, and that he will keep his hand on the regulator handle, following up the variations of cut with changes of speed so closely as to get more work out of his machine-tool than had ever been dreamed of in our old philosophy.

Many very neat arrangements have been made of tools and direct driving motors, several examples of which are given. Naturally rotating machinery, such as lathes and drilling machines, lend themselves most readily to such combinations, which up to the present are mostly the production of motor manufacturers. The direct driving of the planing machine, with the abolition of the cumbersome reversing gear, will present a problem of greater difficulty for the electrical and mechanical engineer.

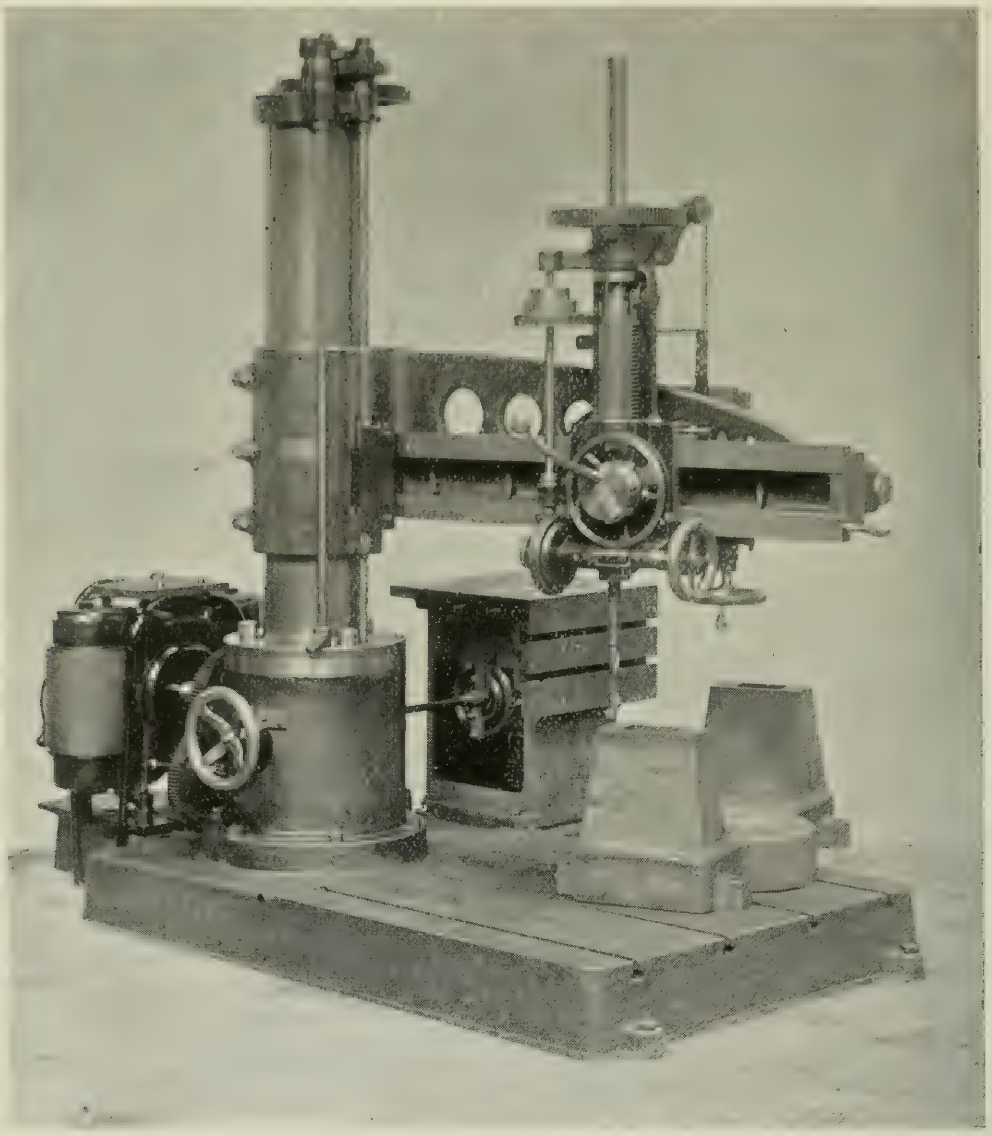
It cannot be questioned that there are many applications of the direct-driven machine-tool which fully justify the claims put forward for it. If it displaces a tool so remote from the engine-room as to require a special engine, the chances are that a comparison will give



SHOPS OF MARION STEAM SHOVEL CO.—GENERAL ELECTRIC MOTOR OPERATING VARIOUS MACHINES.



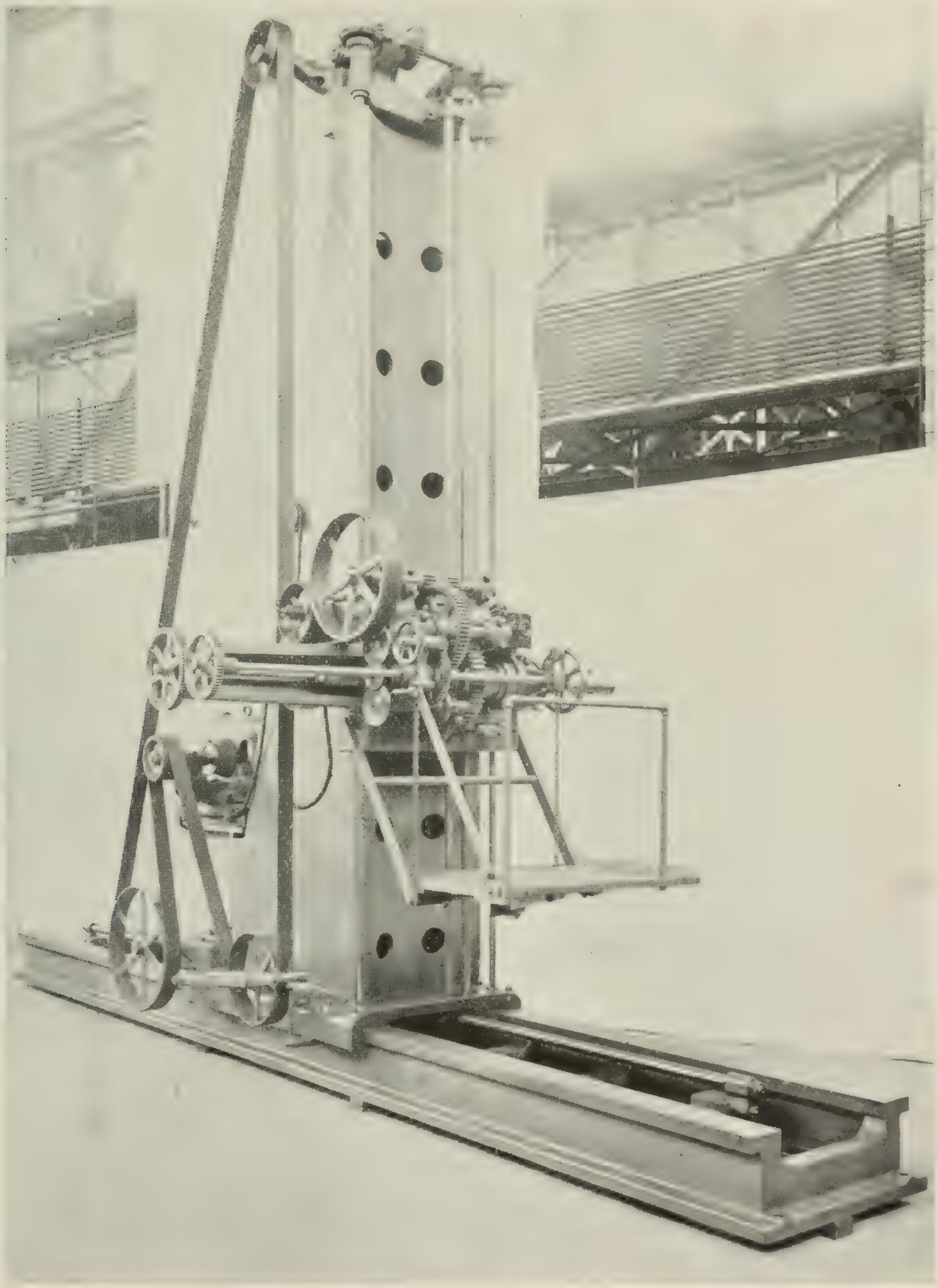
A LODGE AND DAVIS LATHE DRIVEN BY A CARD MOTOR.



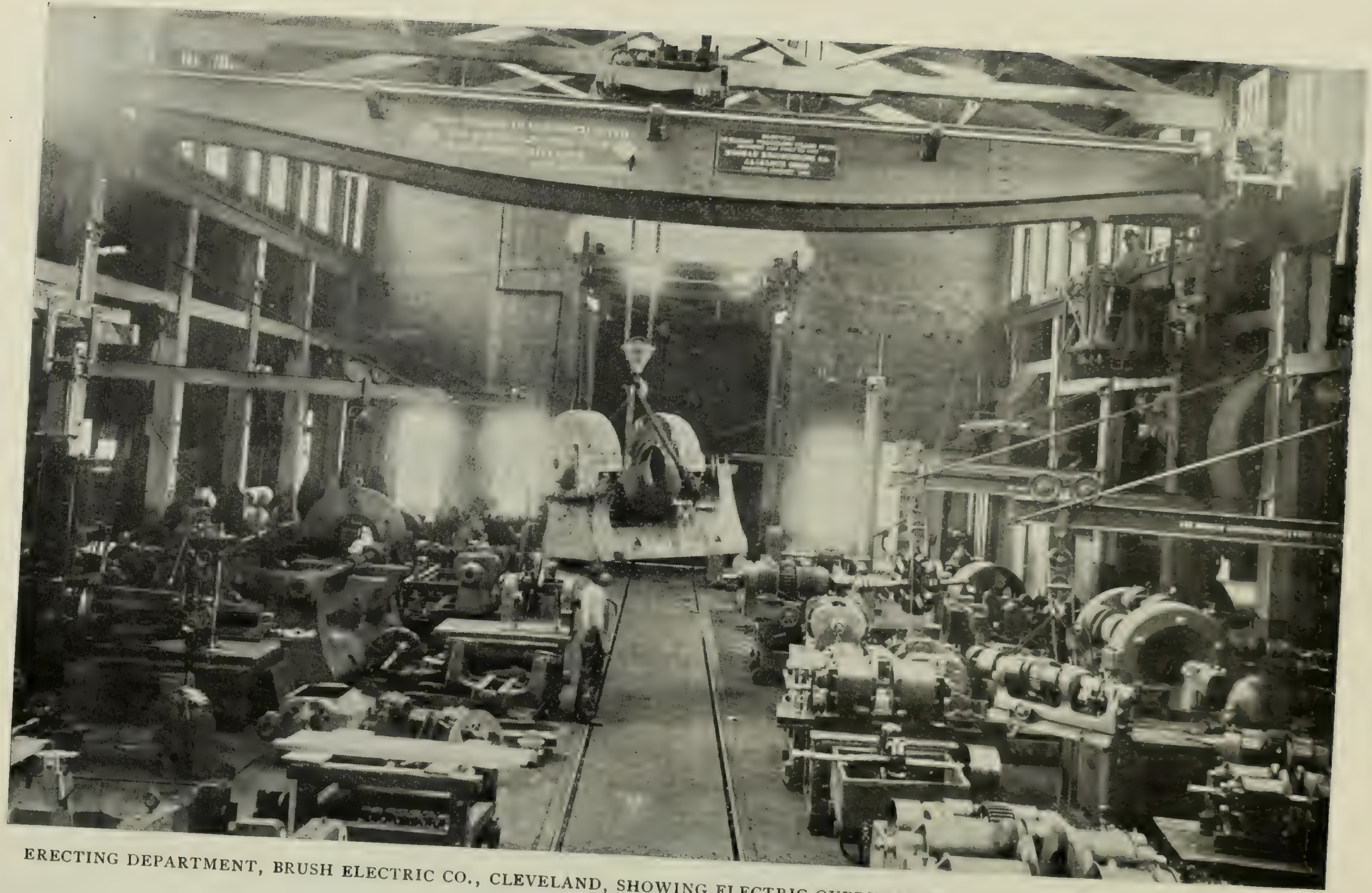
A CARD MOTOR OPERATING A RADIAL DRILL.

some very pretty figures, which, however, will have the proverbial falsity when applied to the case in hand,—namely, that of an ordinary machine shop furnished with directly-driven tools. For, in the present state of the art, it can hardly be seriously claimed that such a shop could be run with a less expenditure of motive power than one fitted up with reasonably efficient shaft transmission.

In an ordinary machine-shop the majority of the tools require a very small amount of power to run them under average conditions, nor does this amount of power vary so much as a casual glance at the belt connections would suggest. As the direct-coupled motor must be prepared to furnish the maximum power required, this means of course that the motors are habitually run at considerably less than their rated capacity. With the increased use of direct-coupled machines statistics will no doubt be obtained as to the ratio between the maximum and average power required, for the observations will be comparatively easy to make. In the meantime the practice seems to be to provide a motor of ample capacity, and this in itself is a cause of some



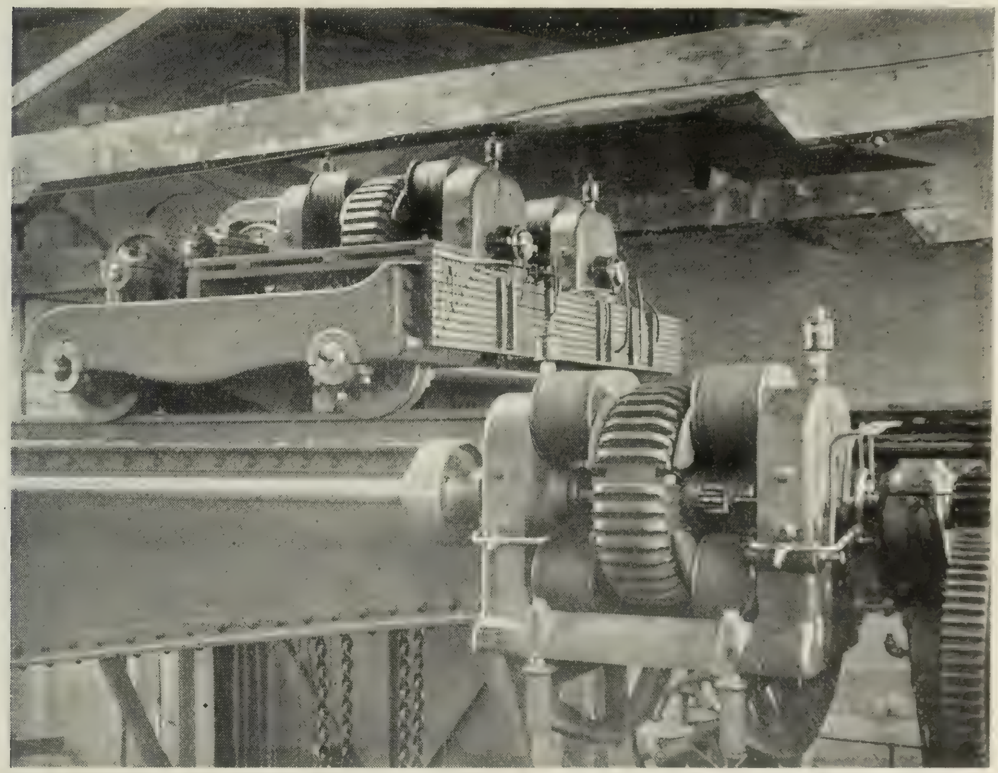
A SELLERS FLOOR BORING MACHINE AT CRAMP'S SHIP YARDS.



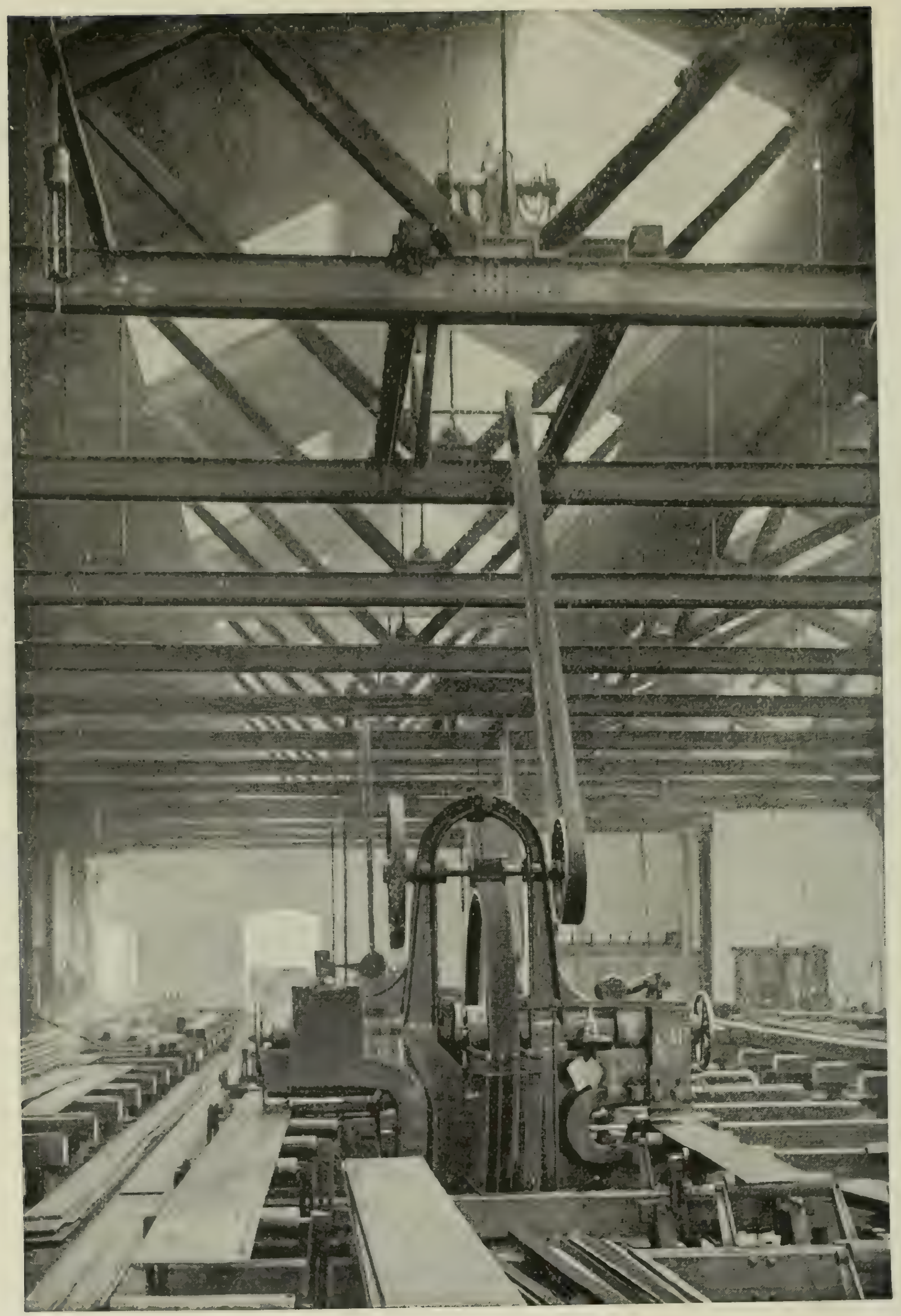
ERECTING DEPARTMENT, BRUSH ELECTRIC CO., CLEVELAND, SHOWING ELECTRIC OVERHEAD TRAVELING CRANE, CAPACITY 15 TONS.

misgivings on the part of the machinist. He has a lively recollection of instances where the disastrous results of carelessness or inattention have been averted by the kindly habit the belt has of slipping or running off altogether when an unsolvable problem is presented to it, and the question arises whether the safety fuse can be depended on to the same extent under similar circumstances.

Assuming that the bulk of the machine-tools in the average shop require less than one horse-power each to run them, and that the motors are run at very much less than their rated capacity, it would at the present time be rash to expect from them a higher average efficiency than 60 or 70 per cent. The dynamo supplying the motors will also be run under conditions unfavorable to maximum efficiency, the average power being considerably less than its rated capacity and fluctuating more or less violently. An efficiency, therefore, of 85 or 90 per cent. may be considered satisfactory for plants of moderate size. If we take the smaller efficiencies, then one horse-power utilized requires the furnishing of 1.96 horse-power by the engine. Allowing 2 per cent. for work wasted in the leads, we obtain as a result that 50 per cent. of the work delivered by the engine is absorbed in transmission. If we take the higher efficiencies,—namely, 90 per cent. for the generator and 70 per cent. for the motor,—then 1.6 horse-power must be



BRUSH MOTORS OPERATING TRAVELING CRANE.—SEE PAGE 680.



SHOPS OF WROUGHT IRON BRIDGE CO., GENERAL ELECTRIC MOTOR OPERATING PUNCH AND SHEAR.

furnished for every horse-power utilized, and, adding 2 per cent. for the leads, more than 27 per cent. of the work furnished by the engine is absorbed in transmission. If the time required to take care of the large number of motors employed were devoted to keeping the usual system of transmission in order, it cannot be doubted that in point of economy the advantage would remain with the latter.

It may be objected that the fact so often insisted on—namely, that, while the machine tool is not in operation, no work is being done on its account—has been ignored. This, though very important in some applications, is less so in the case of an ordinary machine shop where the majority of the tools are running with short intermission. Moreover, the stopping of the motor does not diminish the friction of either the engine or the generator; the saving therefore is at most the difference between the friction of the line shaft and that of the generator, since the countershaft connections could usually be cut off by suitable clutches if the saving effected were sufficient to warrant the expense.

For driving larger tools subject to intermittent use and distributed over a large area, electric transmission may be expected to make a better showing on the score of economy, besides securing the important advantage of a clear head-way. Such an installation was made by the late E. V. Clemens, while superintendent, in the erecting shop of the De La Vergne Refrigerating Machine Company, New York. When this was completed in 1892, some of the heavier tools were removed into it and adapted to operation by independent motors. The full advantage of direct coupling could not of course be obtained in this case, but the necessary countershafting is attached to the walls of the building below and well out of the range of action of the traveling crane.

The tools thus operated are as follows:—

10 × 10 × 30 feet Planer	15 H.P
15 feet Boring Mill	10 H.P
18 inch Slotter (2)	10 H.P
64 inch Corliss Boring Mill	10 H.P
Rumbler	3 H.P
Crane (2) 10	20 H.P
" (1) 5	5 H.P
Lathe	2 H.P
	75 H.P

All the motors are of the C & C type, running at about 1100 revolutions, the crane being the Morgan three-motor type, having a lifting capacity of 15 tons, a span of 52 feet, and a clear height of 24 feet 10 inches. The current is produced by two 40 horse-power Thomson-Houston generators run by a 100 horse-power vertical Hewes

& Phillips engine. In actual practice one generator is found to be sufficient, though it is rather severely taxed at periods when the crane is operated at the same time that the planing machine is run on a short cut. This latter machine was at first supplied by a 10 horse-power motor, but reversing was found to slow it up too much, notwithstanding the addition of a fly-wheel, so that a 15 horse-power motor was substituted. The table on page 685 represents the results of a trial extending over five weeks, giving the time run by each motor and the machine driven by it, the average horse-power delivered as determined from the Watt-meter, and average of these for the whole period. The indicated horse-power calculated as the average results of some 40 cards was 23.98. Although the times of taking the cards were arranged with a view of obtaining a fair average result, nothing short of a continuous record could, under the circumstances of fluctuation, give perfectly reliable results. That these were probably near the truth was considered to be shown by the fact that the friction of the engine generator, and intermediate connections, accounted for 13.4 horse-power of the 14.3 horse-power of missing work. It was intended to ascertain the amount of work consumed by each tool, but the observations were rendered of little value in consequence of a subsequently discovered defect in the instruments. However, the amount of work to be credited to any one machine (including the proportional amount of the loss in the leads) can be written down directly from the above table in the determinant form, the reduction of which however would probably involve more labor than the information is worth.

Before making any deductions from the facts here disclosed, it may be observed that, under the circumstances of the trial, a 50 horse-power engine would have been sufficient for the purpose, provision having been made for extending the plant. We may deduct say 6 horse-power from the lost work, so that 18 indicated horse-power would have been supplied. If we allow 6 horse-power for the friction of the engine itself, this leaves 12 horse-power furnished, of which 2.22 was consumed in the counter-shafting and dynamo and a further (probably small) amount in the leads. Considering the location of the machines, this may be considered a very fair showing in comparison with the cost of running shafting —and, in view of the convenience, eminently satisfactory. These figures cannot fail to suggest a solution which might reduce the first cost of such an installation, for, since less than 10 horse-power is called for on the average, why should not a 15 horse-power engine, with storage batteries, run it?

Neither the relative cost of installation nor that of maintenance have been discussed, for the reason that, while at the present day the

TEST OF THE ELECTRIC POWER PLANT OF THE DE LA VERGNE REFRIGERATING MACHINE COMPANY.

1892.	Average horse power from wattmeter.	RUNNING TIME OF MOTORS.														Working Time.	
		Planer.		Drill.		Drill.		Horizontal Drill.		Slotter.		Boring Mill.		Crane.			
		h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.
Nov. 28	9.00	9	45	0	45	2	40	3	15	8	23			6	27	10	00
" 29	9.33	8	15	3	30	3	50	6	55	8	35			3	54	10	00
" 30	8.52	3	30	1	35	1	05	3	25	8	37	9	30	4	10	10	00
Dec. 1	10.93	8	00					4	20	8	01	2	50	4	59	10	00
" 2	8 11	7	30	1	00	2	20	6	15	8	16			4	32	10	00
" 3	9 35	7	15	3	05	2	30	6	15	7	15			4	22	8	45
" 4	Sunday																
" 5	8.11	7	00	0	45			3	55	7	17			7	55	9	55
" 6	7.88	7	45	1	05			6	20	7	55			6	09	10	00
" 7	8.69	8	35	0	50			5	15	9	35			5	23	10	00
" 8	9 33	9	25					6	35	8	48	1	40	6	10	10	00
" 9	11.09	9	00	2	00			7	15	8	37	4	10	7	09	10	00
" 10	9.47	7	15	0	45			6	15	8	27	4	30	5	09	9	00
" 11	Sunday																
" 12	10.13	7	04	5	00			5	55	8	32	1	30	7	21	10	00
" 13	9.30	6	21	5	00	1	20	7	35	9	35			6	14	10	00
" 14	8.35	9	08	0	30	5	25	7	55	8	24			4	41	10	00
" 15	9.15	7	39					5	45	9	22			6	34	10	00
" 16	9.00	6	37	1	30	2	35	7	00	8	32			7	03	10	00
" 17	10.47	6	35	1	00	0	30	6	45	8	25			3	56	8	45
" 18	Sunday																
" 19	9.97	9	05	3	00			7	55	8	22			7	05	10	00
" 20	9.65	8	40	2	00			7	00	9	40			7	35	10	00
" 21	9.25	8	40	0	55			5	05	8	22			8	20	9	55
" 22	8.09	7	20	1	40					7	47			6	40	9	55
" 23	10.61	7	40	2	25			6	50	8	25	1	05	6	39	10	00
" 24	11.08	5	43	3	10			5	20	8	12	6	45	5	10	9	00
" 25	Sunday																
" 26	Holiday																
" 27	14.00	8	10	3	50	2	05	7	55	8	12	6	30	8	30	10	00
" 28	10.13	6	26	4	20	2	00	7	45	9	29	2	55	8	05	10	00
" 29	9.47	8	25	1	50			5	05	7	20	2	10	7	00	10	00
" 30	10.61	10	00	1	20	3	45	6	15	8	22	2	51	6	50	10	00
" 31	11.98	9	00	2	05	1	55	5	30	8	19	2	05	6	35	9	00
Average	9.63	7	47	1	54	1	06	5	55	8	27	1	40	6	13		

equipment of direct coupled motors is undoubtedly more costly than shaft transmission, the difference will ultimately decrease very materially when the selling price of motors shall become more nearly related to the weight of metal employed in their construction ; and, although the maintenance of several hundred motors may seem an appalling undertaking, we may reasonably expect that, when pursued systematically, especially in view of continued improvements, it will be found no worse than the constant vigilance required to keep shaft transmission in order, with its lining up of shafting, oiling of hangers, taking up and repairing of belting, etc.

The method of grouping a number of machines around a motor is at best only a transitory and temporary solution, and, while it may be employed with advantage under certain existing circumstances, it possesses few of the advantages of the direct coupled method and disadvantages of its own. It retains the use of belting and countershafting, and, when the motor fails, the whole group of machines dependent on it is brought to a standstill.

It is not believed, of course, that existing machine shops will reconstruct their plants to adopt the direct coupled method, but doubtless many such intermediate applications as that of the De La Vergne Refrigerating Machine Company, Fraser & Chalmers, and others will be made. If the collateral advantages claimed for independent driving are real, it is a matter of small moment whether the cost of running is greater or less than that of shaft transmission. If it can be demonstrated that materially more work is got out of the machine, this will be the controlling factor. The number of men employed per horse-power varies very much in different shops. The average of the ten cited is about three men per gross horse-power.

If an engine uses four pounds of coal at $3 per ton per horse-power, the cost of the latter per hour is 6 mills. To utilize this, if we allow 20 cents per hour as the average wage, 60 cents is paid in wages alone, leaving out interest on cost and depreciation of the tool. Thus *one per cent.* increase in the efficiency of the tool would compensate a doubling up of the total horse-power now employed on the average in the ten shops referred to. Hence the money value in any possible difference in the cost of transmission, sinks into insignificance before only a small percentage of increase in the efficiency of the tool.

Does direct electric coupling increase the efficiency of the tool, if so, to what extent? This is a proposition somewhat difficult to prove in view of the many elements entering into it, but it is one to which the advocates of the system must principally address themselves.

FIRST PRINCIPLES IN ARCHITECTURE.

SECOND PAPER.

By Prof. Wm. H. Goodyear.

THE last sentence of my previous article read originally, "The architect of the future is an engineer"—and therewith the paper ended.

Impressed by this sentence, the editor of THE ENGINEERING MAGAZINE has requested that I undertake to explain this sentiment, or to vindicate it. I take pleasure in responding to the invitation, but in doing so it becomes necessary to say that the reading of my preceding paper is almost essential to the proper understanding of the present one.

I have shown that our historic styles are none of them traditions which connect with the original historic past, and that consequently they have not profited by its experience,—that they are purely superficial imitations, which in themselves neither do much harm or much good. They do not do much good, because the superficial appearances of the supposed model, if they were virtues once, could not very well be virtues now, the conditions of life and culture being different. They do not do much harm, because genius and common sense are more or less superior to the self-deception which the very use of the term "historic style" seems to imply.

So far my editor considers my argument destructive rather than constructive. It points to certain inherent and necessary weaknesses in all architecture which rests on an ideal of imitating historic styles for literary, sentimental, and archæologic reasons.

Very well, then ; what shall we do in a positive sense, if we are not to be literary? My answer is "We are not to be literary, but practical." If I am asked "How shall we be practical?" my answer is, "Be practical." If these answers be considered frivolous, I should then say "Educate the consumer, or the patron." In a word, "Educate the public." To put a little plainer point on it—"Stop blaming the architects."

I will take an example from last night's newspaper, in which it appeared that a mansion at Asheville, N. C., is "modeled after the château of Blois." On the strength of this piece of news the following questions suggest themselves. First, supposing the alleged news to be true, we observe that the newspaper does not say that the mansion is "alleged" to have been modeled after the château of Blois.

So far from guarding against a suit for libel, as is customary where news damaging to the reputation is printed, it does not appear that the news was supposed to be damaging either to the owner or architect of the mansion. If it were said by the same newspaper that Mr. Gilder had modeled his last poem after one of Shakespeare's sonnets, the word "alleged" would probably have appeared in the report, which otherwise would have been libelous in spirit, if not in law. Why should the architect hasten to announce what the man of letters would be anxious to conceal? The answer lies with the public, whose standard of style in literature is originality, and, in architecture—the want of it.

Second, still keeping to our concrete example, the question suggests itself: "If the mansion at Asheville be really modeled after the château of Blois, would it not be well to inquire what the château of Blois is modeled after?" If it should appear that the château of Blois is an original design, why should not the mansion at Asheville be another?

In this way of looking at things we should come to a curious result. If the architect of the Asheville mansion were talking to me, we should undoubtedly agree in considering the Asheville mansion an original design but, when he is talking to the owner of the mansion, it is "modeled after the château of Blois." A possible or probable thing is that the owner of the mansion, after visiting the château of Blois, thought that he would like to have another, ordered it, and was told that he got it and believed it, and got something a good deal better than if he had gotten what he ordered.

Is there an eminent architect in this world who does not know that *the frank exhibition* of construction is the one test of good architecture, that the first and main mission of ornament is to emphasize construction, and that the conditions of construction change with every new century of history? Hardly. Why, then, should I bleat this lesson in his ears?

Is there a man of common sense in this world who believes that the life of the sixteenth century is being lived at Asheville, N. C.? Hardly. Why, then, should I bleat the lesson in *his* ears that it is not being lived there?

Here comes the rub. The man of common sense knows nothing about art, because he does not know that art is common sense. Therefore I say "Educate the public."

No easy task that—and yet it is being done. Witness the transformation in American art between 1876 and 1894. What makes our task difficult? First and foremost, the specializing of pursuits and interests. I know nothing about chemistry, and my friend, who is a chemist, can look at the entrance of the new Salvation Army building on 14th street without shuddering. The modern eye is dulled, blunted, and careless. It literally looks without seeing. Why should we goad our architects to a perfection which would not be recognized? In so far as certain human faculties are specialized, in so far are the other faculties atrophied. The man of the sixteenth century, or any earlier century since the Egyptians, was much more equably organized than the man of the nineteenth century. He did everything better, because he did not do so many things thoroughly. As literature and books have come in to supplant pictures and sculpture as educational instruments; as personal and private interests have come in to supplant public pride and civic patriotism,—so have the arts of form declined. To teach people to see we must first teach them to look. Even this is difficult in our age of hurry and pre-occupation. But we may at least complete the literary education we have begun. It is our pride to belong to the first century which has ever made a scientific study and conquest of history. As we were growing up to that conquest of history in the last three centuries, we stopped by the way, in our enthusiasm for Rome and Greece and the Gothic communes, to imitate even their buildings. We have carried these studies farther and deeper, till, as historic students, we see that this imitation was an absurdity, a grotesque abortion of the original, an injustice to ourselves. This is the present knowledge of the historic student; let that too pass to the public which has learned so much of history already. And here comes in the fatal weakness of the mansion "which is modeled after the château of Blois." It does not, alas! represent an enthusiasm for the sixteenth century and Francis I. That much at least in a corresponding sense did our earlier modern Roman and Greek and Gothic do, for the given time which was imitated. An honest enthusiasm for history at least was there. Not so at Asheville. Even the tradition of a tradition has paled, and man does what he did do—not even with the virtue of committing a good, honest mistake. His predecessor was a student of history, who made the mistake of an enthusiasm for history. *He* is living in a time when history is a science and not an enthusiasm; *he* is not an enthusiast and not a historian; and yet he is doing, or rather only pretending to do, what an enthusiast did *because* he was a historian. Of all things on earth I am fondest of the opera bouffe. That is why I like the nineteenth century which alone produced it.

To come back then to our programme for practical improvement. To teach the public its errors of theory and conception is to do something practical. When that is done, let the architects do the rest. It is their affair, not mine.

To the public and not to the architect I address myself in the following hints. You are beginning to travel and to admire historic buildings. Your next business is to find out *why* they are admirable. When you have found that out, you will never admire a copy—*because* it is a copy; and your reporter will never put in your newspaper that your mansion is modeled after the château of Blois, unless he wishes to hurt your feelings—which we know that he occasionally *does* wish to do.

Consider the possibilities and proprieties of architecture according to location and destination. The problem which interests an architect is the problem of designing a building which can be seen on all sides,—where masses can be balanced and contrasted, and effects built up by masses. The problem of a façade for a pretentious city building, cooped up between other buildings,—a mere front,—is, properly speaking, no problem at all. The best way to solve it is not to try.

Architecture is not advertising. Do not advertise your bank or your insurance building by a pretentious façade; because every art work is a failure that tries to advertise. Every person of cultivated architectural taste is pleased by large expanses of masonry surface, and is willing to be satisfied with them. Hence our best city efforts are apt to be the armories and storage buildings, where common sense still calls for simplicity. Whatever ornamental treatment is given to the building material should in the first place develop the ideas of the necessary construction. Your main constructive lines in a business front are the lines of the stories and of the roof. Do not obscure these lines by so-called architecture. Do not allow cornices as heavy as the roof cornice on the other stories of your building. If the building is a sky-scraper, do not be ashamed of it, but glory in it. The higher the building the better—and the higher it looks the better. No need to bind stories together and obliterate them by a "tasteful composition" because the building is high.

City architecture, so far as it consists of dwelling houses, stores, warehouses, and other business buildings, in solid blocks, should rest satisfied with great simplicity. If our business men were content to let their buildings reflect their own business qualities and business character, the calling of the critic would disappear. All art is satisfactory as it corresponds with character—with utility. If a people is frivolous, ostentatious, and pretentious, its architecture will reflect these traits; but we know that business men do not reach success by anything but business qualities. Let them be as economical in exterior show as they are in paying their book-keepers and office-boys, and New York city would be a paradise for my feeling. Let them be as bold in their choice of a façade composition as they are in making a Wall street corner, and our architecture would rival the Egyptian.

Let the man of business avoid expensive pediments and broken cornice lines as he avoids a bad debt. One may be as expensive as the other. Both are bad debts. One may be forgotten, but the other is always staring us in the face. As far as I am concerned, the sense of wasted money, and money wasted by men who are supposed to be experts in keeping it, is what I get from pretentious shop and bank façades. Our brokers and bankers and shop-keepers are not heroes; they are not men of science; sometimes they are not even statesmen; but they are supposed to be men of business. Why, then, should their architecture not be business?

In this matter of stern and simple reticence in business buildings, Chicago is far superior to New York, and to Philadelphia. Possibly it was compulsion dating from the time of the fire. The odd thing is that good architecture has always very largely been compulsion. The architrave and frieze which we have borrowed from the Greeks and Romans and scattered in ornamental copy over the fronts of our buildings was compulsion to the Egyptian, because he used in temples a flat stone roof which rested on one line of stone beams, and was faced in front by another. The buttress and pointed arch were compulsion to the Gothic architect; his building would have tumbled down without them. When there is no more money to waste, and banks and insurance companies are run on a closer margin, I look for a great improvement in New York.

These, then, are my views for cities about architecture in blocks of any kind. Stated briefly, they are "Don't have any"—Punch's advice to people about to get married: "Don't." What the cultivated eye is looking for is general effect. If we are to get any general effect in our crowded streets of buildings of unequal height and unequal width, it must be, first, by repose of surfaces; second, by abandoning the system of cornices devised for one point of view and seen from fifty; third, by shadow effects of doors and windows which are not tormented with projected canopies and pediments; fourth, by the picturesque irregularity of one building as against another. This irregularity can only be picturesque when there is some sort of correspondence in appearance between the front and the sides of a building. A more truly ludicrous spectacle is not to be seen in the world than our series of pretentious façades with heavily projected cornices and moldings, as facing on the street and designed for front view—not worth much at that—and rearing a series of side walls which are politely considered outside the problem of the architect, because some other time some other fellow is going to cover them up. In heaven's name, if so thoughtful of economy on the sides, give us a little of this economy in front. Street lines of medieval houses closely packed are still to be seen in many European towns. They are delightfully picturesque, simply because the irregular fronts are as unpretentious as the irregular sides.

No doubt our city block architecture, business or domestic, suffers from three causes—ostentation, advertising effort, and honest ignorance; bad taste, that is, which might be improved by taste education. The ostentation and the advertising effort go back to traits of character and culture with which the art critic has no business to grapple, because they are wholly incurable. On the other hand, no expert can deny that we have witnessed in the last twenty years a magnificent improvement in the points on which I take issue with city block architecture. The whole Queen Anne, Italian Gothic, and Romanesque movement has really been a movement for plain masonry surface and the abandonment of projected detail. Oases of refinement can be picked out all over New York city in the architecture of the solid blocks, and I leave it to other critics to say if these oases are not generally marked by simple reticence, aside from those little traits of refinement in detail which, like the tone of the voice or the expression of the face, denote the person of culture.

We will turn next to the problem of public buildings,—buildings which stand free and can be seen on all sides. It is conceded that our government buildings—municipal, State, or national—are, generally speaking, our worst efforts. Americans are apt to be "agin the government" and are always willing to laugh at themselves if the government is in fault. This is possibly not an advantage. It does not favor improvement. It is pretty generally understood that many of our United States buildings have been designed by West Point officers, which is equal to saying that they are wholly out of touch with the new movement in architecture. It is in the matter of public buildings that we begin to raise comparison with older architecture. The problems of our city block architecture are partly new, but the only way to solve them is not to try. This is what the ancients and the Middle Ages did. When we come to public buildings, comparison with the past is inevitable. We will now say this general word on modern architecture. Its weakness is anxiety,—trying too hard. It is only supreme genius which can make an effort to conquer attention without suffering from the weakness of effect which goes with the sense of effort. Literature, the stage, and the art of the painter and sculptor all teach one lesson. Repose is always success, and it is always success because it always represents a sense of power. Lack of repose is shown in personal conduct by over-affability or by over-dress. The one general defect of all modern architecture is the anxiety to please (and, let us add, the anxiety to please the wrong people).

Much of our modern building makes the same impression on me which I receive from an over-dressed person. Now, repose is power, but it is power which may rise to a supreme effort, sure of success and therefore certain to achieve it. For that too conquers the attention, —that the artist knows he can succeed. The brilliant beauty of the ballroom is never over-dressed; but let the woman who does not realize her power, or who has none, wear the same dress, and the woman is over-dressed. Now, the force of character which means power in building, or elsewhere, means repose in general; but it also means supreme and triumphant effort. The streets of Athens were bare walls in the days which built the Parthenon. The streets of Rouen were timber and plastered walls when its Gothic churches rose to power. Modern architecture shows by its pretentious street façades why it is not over-successful in public buildings. Character and public spirit are both wanting to us by contrast with older days. What absurdity to ask of an architect the character which we do not possess ourselves! None the less do the Pittsburgh court house, the Albany town hall, and the Hartford capitol, and many other buildings, show that we are not all or wholly weaklings in these later days.

The one grand law of all public as of all private architecture is to begin by planning the interior. The exterior which corresponds to that interior is and must be right, if the interior meets the problems of its natural use. Once more I come back to my theme that it is the public, and not the architects, which needs education. As long as the public considers simplicity severe and prison-like; as long as the public does not know good color in brick or good detail in stone; as long as the public wants its mansion modeled after the château of Blois,—why worry the architect with articles in the magazines? I am sure I should not do it if I had not been asked.

We come at last to our most hopeful topic,—the country-house architecture of America. Doubtless here, too, there is much over-striving and over-effort; but no one can ride around the suburban places which surround our cities without feeling that an immense amount of refinement, of character, of individuality, of artistic taste, and of honest hard work has gone into American architecture in the last twenty-five years. Is this partly because the decorative art movement has had fuller sway here? I think so. Whatever be the causes, the fact is there,—that American country-house architecture leads the world and claims the first place (according to my view) in all modern architecture.

Among the causes we may suggest the following: the absence of the business advertising idea; the absence (generally speaking) of the ostentatious element; the influence of feminine good taste; the necessary exercise of individual discrimination in the matter of plans and arrangement ; the necessary reflex in the variety of lines, masses, and shadows of the exterior ; the fact that the architect *can* design an exterior, and does not have to design a mere front. If I were to add a crowning cause of the success, I should consider it to lie in the absence of that soul-crippling theory of historic styles which has ruined our city architecture ; for who does not know that "Queen Anne" and "Colonial" are convenient fibs of the architect who is called on to name the "style" supposed to be chosen for the country house.

A last word as to principles of taste in architecture. In dress, in utensils, in furniture, and in buildings, we only recognize one law for ornament,—viz., emphasis on the facts which ought to be emphasized. Points of support and of pressure, joints and connections, seams, borders, outlines, terminal points and terminal lines—these are the things to be brought out by ornamental detail. Construction may be exhibited frankly, or the interior facts may be brought out by exterior suggestion. Compare the treatment of the lines of the stories on the Florentine Strozzi palace, which suggest the facts regarding the main interior stories, although these lines are not in construction connected with them. That form is pleasing to good taste which shows and reveals its use. That form reveals the use most successfully whose surface and outlines, and whose skeleton or frame, speak for themselves, and are not obscured by misplaced ornament. In dwelling on the power of surfaces we must not forget the power of shadows and of their contrast with surfaces. Given the knowledge and practice of these elementary principles, much lies in genius, in artistic temperament, even in occasional caprice ; but these are the dressing of the salad, not its body or solid contents.

I have said in the conclusion of my last paper that the architect of the future is an engineer. Every engineer is an architect now. When every architect is an engineer,—that is to say, a designer of construction who is not ashamed of his construction,—the problem of modern architecture will have been solved, and the architectural critic will be as useless as training schools for artists would have been in the time of Phidias, or lectures on historic ornament in the cities of the Byzantine empire.

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R of R...Review of Reviews. *m.* $2.50. New York
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Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y
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S M Q....School of Mines Quarterly. $2. N. Y.
S ......Sanitary Record. *m.* 10s. London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis
S P......Sanitary Plumber. *s-m.* $2. New York
S R G....Street Railway Gazette. *w.* $3. Chicago
S R J....Street Railway Journal. *m.* $4. New York
S R R.. .Street Railway Review. *m.* $2. Chicago
S V......Safety Valve. *m.* $1. New York.
T ....Tradesman. *s-m.* $2. Chattanooga, Tenn
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y
T Q......Technology Quarterly. $3. Boston.
Tr.......Transport. *w.* £1. 5s. London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E......Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. Londo

ARCHITECTURE & BUILDING

Great Railway Stations of London.

LONDON railway stations are treated wholly from an architectural standpoint in *The Architect* (London, Nov. 2) in the first number of a series of articles upon the subject. These huge structures which form termini to the great English trunk lines have an architectural interest aside from their special characteristics, arising from the fact that important railway stations have often been made the subject of prize competitions for students of English architectural societies, and at the Royal Academy. "Some of the conceptions elicited, have been awarded medals, and were really excellent. Notwithstanding this encouragement to design of a high order in railway stations, their results appear to have been very meager, so far as the attainment of general architectural excellence in this class of structures is concerned.

"In London of recent years, with the rare exception of the Midland Railway terminus at St. Pancras, and quite lately with the extension of the Great Eastern terminus, the directors, in the assumed interest of the shareholders, have generally insisted on cutting down the architectural part of these overgrown 'sheds' while money has been freely expended on other parts of the building where it was supposed the outlay would 'pay.' At the same time, in the early part of railway enterprise, it must not be forgotten how far otherwise it was, as at Euston, in the great entrance carriage portico, and in the central hall also at Paddington, and to some extent at King's Cross. On the Continent the principal façade and general exterior of the principal stations in cities and towns has had the distinct advantage of being the work of an architect; at any rate the engineer has been materially helped in the art part by the former. The enormous hotels, which in several of the London termini entirely mask the railway station behind, are not so commonly found abroad in this situation, so that the outward suggestion of the internal arrangement is more often patent, which certainly is an advantage."

These points of arrival and departure are among "the more important factors of national life." The large majority of the population constantly resort to them for business or pleasure, and being legally public resorts for orderly people, it would seem that here, if anywhere, a reason for good architectural design exists, and that an opportunity for its exercise should be afforded.

The Great Western terminus at Paddington has no architectural pretensions. Both its site and its design combine to defeat any such intent, if the latter ever existed. It stands on low ground, and like most of the other large London stations "one or at most two of its sides are visible to the general public." The interiors have therefore more architectural interest than the exteriors. In describing the ground plans the terms commonly applied to ecclesiastical architecture have have been adopted for convenience.

"In the case of this building, the plan consists of a wide nave and narrow aisles, having span roofs and two transept-like roofs in the total length. As the north and south ends of the transept ends are flush with the sides of the aisles, the term must be taken in rather a Pickwickian sense. There seems no particular object beyond appearance in this arrangement, which must be more expensive constructionally than running the nave and aisles east to west continuously, like the ordinary plan of Gothic churches. But the writer has often admired its effectiveness and the very striking look of the great diagonal ribs at the junction of the several roofs. Though the nave or central roof is considerably wider than the aisles, the roof construction is the same, being that of a series of arched flanged iron trusses (without any tie-rods) set not far apart, the principals being occasionally perforated by quartrefoils and other geometrical forms, and only panelled near the springing-line with ornament of a semi-Gothic, semi-Moorish character. The upper part of the roof is glazed on that useful plan, the ridge-and-furrow construction. The late Owen Jones was wisely consulted by the promoters in its decorative features, and though one of the earliest built, it still well passes muster as compared with later examples of the London terminus."

What is styled "the more modern idea," has been "fostered by the ambition of railway directors, and arose from the enterprise of civil engineers." This idea is "to roof all in one span." This has introduced "unnecessary difficulties such as would not have occurred had more subdivisions of the width been adopted. The idea of inclosing all under one by roof was a pretty one, but in practice it will be found that the placing of intermediate supports necessitated by several spans causes no inconvenience, as is evident on inspecting some of the large London stations. Possibly smoke and steam hang less about the large one-span roofs than in the subdivided ones. On the other hand there is the disadvantage that in the former type the size of the huge roof destroys the scale of everything near and beneath it.

"The terminus of the Great Northern railway at King's Cross certainly has nothing whatever meretricious in the design of its façade, which is honest and plain enough in all truth, built substantially of stock brick without any other material being used. There is the clock turret in the center, of campanile-like character, and what some ultrapurists would call that dreadful 'sham,' for all else is mere front. But in this case everything is transparent, for any one can peep through the big arched glass panels at the south side of the station and see the horizontal cornice sailing serenely above, regardless of what is obviously beneath and behind. Who is the worse for this? Who is deceived, speaking artistically? Nobody of course. Though treated in a rather crude way, this façade is a good example of that gentle veiling of what in all likelihood would have been an ugly termination, considering the ordinary section of a station roof. Those two arches of great width at the front of this two-aisled terminus, with their several brick rings and orders, were considered a marvel when built, and even now arrest the attention of those who use their eyes. The writer is of decided opinion that in these immense stations, with the large-spanned roofs of the customary type, it is better to make the ends as done here, or by a hotel or other buildings, so as to effectually stop the big unmanageable shed end."

The Granite City.

SCOTCH granite is noted the world over for its enduring qualities and its beautiful texture. Very few stones suitable for building or for monuments take a more elegant polish or present a finer appearance when polished. Its weathering quality is so much superior to that of marble that it has very largely replaced the latter in American cemeteries, and very fine effects in modern architecture have been obtained by the use of this material. The city of Aberdeen, in Scotland, is the center of the Scotch granite trade, and it is practically a city of granite. *Stone*, which gives in its November number an illustrated description of the "Granite City," as it is called, and of the trade in granite, its chief commerce, says it is "one of the best built cities in the wide world." "Its principal street (Union) is a thoroughfare of which any great capital might be proud." However, in the mists and storms which frequently visit that part of Scotland, "a city built of gray granite and roofed with black slate is not enchanting." Seen under aspects of sunshine, or moonlight, the city would probably present a less somber appearance.

The granite of which the city is built is obtained from the celebrated Kenmay quarries, which lie about seventy miles distant. "The largest of these quarries is 300 feet in depth and is worked by means of a gigantic crane and a 'blondin,'" the latter being a wire rope stretched over a quarry at an incline. On this is run an attachment which can be placed in any position, underneath the rope, or it can be lowered into the quarry below. The stone obtained from this quarry is gray, flecked with light brown.

Other quarries are the Dancing Cairns—stone a light blue or grayish tint, the Rubislaw, whose product is grayish blue in color and very fine grained, the Peterhead, forty-four miles from Aberdeen, producing red granite of extremely fine quality, the Hill O' Fare, yielding dark red fine grained stone, and the Corrennie, whose output is of pale salmon color, much esteemed in some quarters, and stated to be always in good demand.

"Every stone mason in Aberdeen is a granite-cutter. Needs must be when granite is the one material out of which all masonry is worked. As a consequence the firms who cut to polish have the pick of some 3000 men, of whom they can give employment to about one-half. The remainder are engaged in various building operations. About 600 men are engaged as polishers. The masons are at present paid 6½d. per hour in the yards. They get 7½d. outside, but prefer constant occupation under cover at the lower wage to precarious employment liable to weather interruption outside. The polishers are paid from 4½d. to 5d per hour.

"By a rule of the Stone Masons' Union no firm is allowed to employ a greater number of apprentices than it has masons engaged."

Of late years trade with America has developed fast. The exports have valued thus:

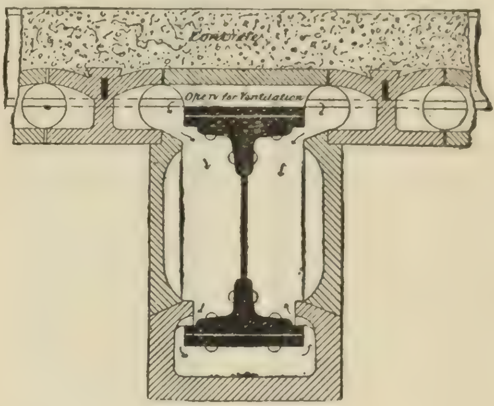
1880	£12,000
1884	26,000
1892	67,000
1893	69,000

At present all agree that the trade is improved. The lowest price ever reached was in the early part of 1894.

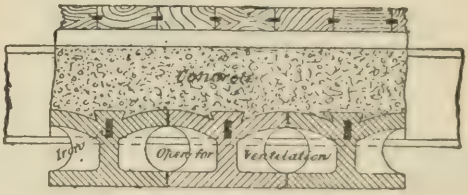
Gypsum as a Fire-proof Material.

A NEW system of fire-proofing has recently been devised in England, and it appears to possess merit. This system is described with a discussion of gypsum as a fire-proof material in *The Illustrated Carpenter and Builder* (London, Nov. 2), with illustrations herewith reproduced.

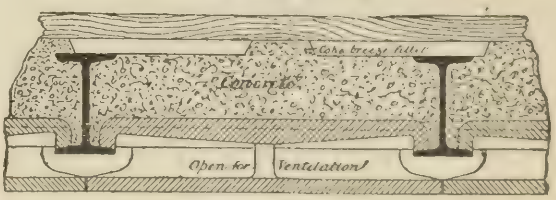
Notwithstanding the extensive use, and general good qualities of gypsum as a fire-proof material, it has one marked defect, namely, that when used in large masses its expansibility is so great as sometimes to cause serious injury to buildings in which it is employed.



CASING TO MAIN GIRDERS.

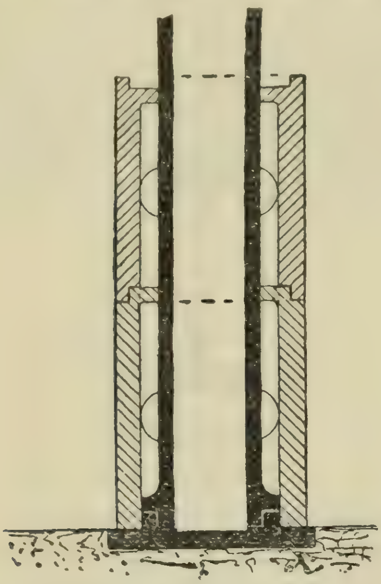


FLOOR, CROSS SECTION.



LONGITUDINAL SECTION.

"The conductivity of gypsum is one-fourth only of slate, and less than one-half of fire-bricks, the relative conducting power of the three materials cited being as 1000 for slate to 620 for fire-brick and 250 for gypsum. In Nottingham and Paris, and other gypsum-bearing districts where that material is used, destruction of buildings by fire is practically unknown. Gypsum was the only material found capable of withstanding the fierce fires in Paris during the Communistic outbreak—fires which were unparalleled in intensity. Mr. R. W. Edis, F. S. A., who was in Paris at the time, and made a minute examination of the ruins, reported to the Congress of British Architects in 1872 that generally throughout all the buildings it was evident that good plaster work, either in walls or ceilings, invariably protected and saved in a great measure materials it covered, and in many cases, while externally the limestone walls had been broken about and calcined by the fire, internally, where plastered, they had suffered comparatively little. Evidence of this kind is beyond dispute. M. Louvier, architect, of Lyons, tested the fire resisting properties of gypsum. A rolled iron joist was placed under a slab of gypsum, and kept at a welding heat by means of a portable forge for more than half an hour without any more than the outer crust being affected, while the strength of the material was not injured. Moreover the results of this experiment were abundantly confirmed by the fact that in some works at Lyons, destroyed by a fire which melted the engines, all the walls that had been constructed of gypsum remained intact, the same being the case at the burnt-down Théâtre des Celestius, Lyons. At the Health Exhibition Conference it was properly pointed out that in fire-resisting floors large iron girders, where necessary owing to the span, should be cased in, to shield them from the direct action of the fire. But a very necessary precaution is to leave the ends of the girders loose on their bearings and with a cavity at the back, because, though the fire does not directly attack the iron girders, it heats them, causing expansion and if bound at the ends they would thrust out the walls."


SECTION OF COLUMN.

Experiments were made to determine whether tiles with cavities or hollows should run parallel or at right angles with the supporting joists, and it was found that the tiles with cavities at right angles to the supporting joists were nearly three times stronger than those with cavities parallel to the supporting joists. A test of the arches by heating, sudden cooling, and by dropping a heavy block of wood on them proved a like relative superiority.

Professor John Goodman, in a lecture given by him at the Yorkshire College, Leeds, on "Fire Prevention," stated that in his experience so far as concrete is concerned, there is no doubt that it is practically fire-proof; "but in conjunction with iron, as generally used, it is to be condemned, from the simple fact that iron, from want of proper protection, expands rapidly under the influence of heat, and consequently disturbs and breaks the rigid concrete, causing it to fall in large masses."

The cuts show the method of fire-proofing girders, columns and floors, and are self-explanatory. They show that lightness, strength, and ventilation are all provided for.

Machinery in Building.

THE remarkable extent to which machinery has superseded hand labor in modern times finds no exception in the art of building. In this art it has become a constant aid not only in the preparation of materials, but in the preparation of sites for building, and in the actual erection of structures stones are sawn and dressed by machinery. Bricks are made by machines. Machine-drilling for blasting has everywhere supplanted hand-drilling. Piles for foundations are driven by steam pile-drivers, and the prepared materials are hoisted by steam instead of being lifted by hand windlasses, or carried up tedious and wearying ladders on the backs or shoulders of men.

But it is in the preparation of timber, the dressing of lumber, and the manufacture of doors, sashes, window-casings, moldings, etc., that machinery has effected the greatest revolution in the art of building. Sixty years ago all, or nearly all, this work was done by carpenters with hand tools from lumber, which, except seasoning, was just as it came from the sawmill. Even shingles were hand made. Now shingles, when used at all, are almost universally made by machinery. Flooring is supplied from the mills planed and matched, all ready for laying. Machine made doors, window-casings, door-casings, sashes, blinds, wainscoting, base-boards, and moldings, leave little for a carpenter to do to fit them to their places.

The Illustrated Carpenter and Builder (London, Oct. 5) discusses the proper machinery outfit for a general builder's business of moderate extent. The question of kinds and capacities is considered on the basis of forty men employed.

"The following engineering plants should meet the requirements, and be well and profitably employed: An engine of not less than 8 horse-power; a circular saw or joiner's bench, to carry a 36-inch circular saw, arranged with a rising and falling spindle and tenoning and boring apparatus; a vertical spindle molding and shaping machine; a hand-power mortising machine; and a mortar mill, with suitable shafting; in all of the value of about $2000. With this plant a very considerable amount of work can be turned out. If the engine is to be fixed permanently, the horizontal type, with a Cornish or Galloway boiler, is to be preferred; if it has to be moved from place to place the ordinary portable engine on wheels is the best form. In this latter case the engine should have light hoisting gear attached, as on a contract of moderate extent this will dispense with the services of several laborers. With the saw bench deals and boards up to 12-inch deep can be converted and cross cut for door stuff, etc.; and all kinds of flatting and deepening, plain or feather-edged boards, matched boards, skirtings, scantlings, etc., can be readily turned out. After the wood has been sawn, it can be tenoned, grooved, tongued, rebated, or bored, as desired, and without the aid of very skilful labor."

One of the most useful machines in a builder's business is a vertical spindle molding and shaping machine by which straight or curved moldings and circular headed or straight sashes may be worked. "On such a machine planing, thicknessing, rebating, shaping and stop-chamfering can be perfectly performed.

"Old pieces of wood may be converted into moldings or otherwise; door rails and similar light work may be planed or thicknessed. It will work as well in oak and hard woods as in pine or the softer woods. Gothic for church decorations, pew backs, and other moldings may be shaped and molded with facility; and if the cutter spindle is arranged to angle, difficult undercut moldings may be produced at an immense saving over hand labor. In fact, this machine properly constructed and worked may be pronounced one of the most valuable of all wood-working machines. The operations of the mortising machine and mortar mill are too well known to need notice."

In establishments, however, where machines for wood-working are used without system, much valuable time is lost. Tools are often out of order, which entails not only loss of time but inferior work. In such establishments machines fail to be so profitable as in other shops where order and system prevails. To be profitable each machine should be under the care of one man whose duty it is to keep it in perfect working order, and as far as possible to operate it himself when work requiring its use presents itself. Duplicate cutter-heads will aid in keeping the machines in order. The cutters should be of best quality.. Great care in sharpening should be taken to preserve the profile of molding cutters.

It is estimated that an outlay of about $2000 would purchase such an outfit as described, and that, say in a job of building six ordinary houses it would, at a cost of about $60 per week, replace the services of fifteen men. It is also suggested that when an estate of some extent has to be built over, it would pay a builder well to hire or purchase a brick machine and make his own bricks. In selecting a brick machine, it is best to have sample bricks made by different machines out of samples of the clay intended to be used, which will help in determining which of those in market is best adapted to working that particular clay.

As to stone working, in the execution of large contracts it might be also profitable for builders to use machinery for it. Portland, Bath, York, and all freestones and sandstones, can now be sawn, planed, or molded by machinery with facility, the work being so well done as not to require subsequent finishing. Even some of the limestones can be thus worked. Sills, heads, string-courses, steps and either plain or molded copings can be produced by machinery much cheaper than by hand labor. Even the harder stones used for flagging, etc., can be surfaced much more cheaply and accurately than by hand work.

Education of Building Trades Workmen.

THE address of Mr. E. W. Montford, president of the Architectural Association, as reported in *The Architect* (London, Nov. 2) contains remarks concerning the better education of workmen in the building trades which are of more than ordinary interest; and in general the address is somewhat above the usual standard of such discourses. Of the scheme for education of workmen originated by Mr. Owen Fleming, a hopeful view is taken.

"Our communications on the subject with the various city companies, the trades unions and other bodies have received general approval, and with your consent a preliminary conference will shortly be held, at which all the above mentioned bodies will be represented. When the subject was first broached the paper *London* was good enough to criticise our action with a good deal of disfavor, but as it was evident that it entirely misunderstood our intentions, no one troubled to reply. They seemed to think that it was an endeavor upon the part of architects, whom they were good enough to call a 'most notoriously ill-educated profession,' to patronize the workmen, and advised us to look to ourselves first. Well, no one can say that the Association has neglected the education of architects. That has been our great object for over fifty years, and for a good many years past we have been fairly successful. Our system is not yet perfect, and probably never will be, but it is as good as we know how to make it for the present, and we shall endeavor to improve it still more as time goes on. So having done our best for ourselves, we naturally desired to help the workmen with whose coöperation we are beautifying more or less, according to our abilities, the face of Great Britain. We have no desire to patronize them (why should we?), but merely to treat them as fellow-workmen with a common object. In helping them we are helping ourselves, for beautiful workmanship may go far to redeem a bad design, while a good design may suffer immensely from bad workmanship. The architect is the chief workman, but absolute success in any building can only be obtained by every workman of every trade employed upon it doing his very best, and uniting in a common effort to make the building in all its parts perfectly beautiful and perfectly strong. It is in this spirit that we are approaching the conference, and if, as I believe, the other workmen understand this, we may hope to produce some beneficial results."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*26658. First Principles in Architecture.—The Coming Architect an Engineer. William H. Goodyear (E Mag–Jan.) 3000 w.

*26663. The Architecture of Municipal Buildings. E. C. Gardner (E Mag–Jan.) 3000 w.

*26712. The Reliance Building, Chicago. Ill. (E–Nov. 2.) 2700 w.

*26741. The Professional Side of Architecture. (Abstract.) E. W. Mountford, with Editorial (B A–Nov. 2.) 4000 w.

*26742. Improvements at the Houses of Parliament (B A–Nov. 2.) 1200 w.

*26758. Gypsum as a Fireproof Material. Ill. (I C B–Nov. 2.) 900 w.

*26767. Decorative Circles. Ill. H. Leslie Ramsey (Pl D–Nov. 1.) 1500 w.

*26769. Wooden Architecture of Norway. Ill. (B–Nov. 3.) 2700 w.

†26781. Description of a Chatty Roof. Ill. D. Upson (I E–Oct. 6.) 500 w.

*26836. The Granite City—Aberdeen. Ill. Arthur Lee (S–Nov.) 1400 w.

*26839. Wilhelm Lübke (A L–Nov. 2.) 2000 w

*26841. Presidential Address of E. W. Mountford (A L–Nov. 2.) 4200 w.

*26842. Stonehenge. (A L–Nov. 2.) 3600 w.

†26891. Emotional Architecture as Compared with Classical. Louis H. Sullivan (I A–Nov.) 6000 w.

†26892. Architectural Education. Henry Van Brunt (I A–Nov.) 2700 w.

26893. High Buildings and Good Architecture. Thomas Hastings (A A–Nov. 17.) 2000 w.

26894. Professional Ethics. John A. Fox (A A–Nov. 17) 1000 w.

26895. Notes on the Early Christian Monuments of Cornwall. Arthur G. Langdon (A A–Nov. 17.) 2700 w.

26902. Test of Terra-Cotta Floor Arches in Rochester, N. Y. Ill. (E R–Nov. 17.) 1000 w.

*26957. Address of F. C. Penrose before the Royal Institute of British Architects (B–Nov. 10.) 10000 w.

*26966. Bending Timber. J. C. B. (I C B–Nov. 9) 700 w.

*26970. Hammerbeam Roofs. Ill. (I C B–Nov. 9.) 1600 w.

27037. Evolution of American Architecture. J. W. Yost (A & B–Nov. 24.) 4500 w.

27057. The Vicar's Close at Wells. Ill. (A A–Nov. 24.) 4400 w.

27068 Steel and Cast Iron in Buildings (I T R–Nov. 22) 700 w.

*27074. The Deposit of Priced Quantities. (Abstract.) John Holden (B A–Nov. 16.) 1400 w

*27078. Old and New Buildings in Edinburgh (I C B–Nov. 16.) 2200 w.

*27083. Convention vs. Invention (I C B–Nov. 16) 2000 w.

*27114. Strength of Arched Iron Ribs. Ill. (B–Nov. 17.) 600 w.

*27115. The Study of Modern Architecture. A. Beresford Pite, with Discussion (B–Nov. 17.) 10500 w.

27141. The Reliance Building, Chicago. Ill. (Sc A S–Dec 1.) 2800 w.

†27234. Straightening a Leaning Chimney 100 Feet High. Ill. Joseph C. Platt (A S M E–Dec.) 1200 w.

27274. Modern Construction of Floors and Partitions in Commercial Stables. Ill. H. J. Campbell (E R–Dec. 1.) 2000 w.

27302. Modern Style Founded on Ancient Greek Architecture. Russell Sturgis (A & B–Dec. 1.) 3500 w.

*27303. The Endurance of Structural Metal Work. C. H. Blackall (B B–Nov.) 3000 w.

*27328. Architecture in Newcastle. (Abstract.) J. Oswald (B A–Nov. 23.) 1200 w.

*27351. The Architecture of China. Frederick M. Gratton, with Discussion (B–Nov. 24) 4500 w.

27360. Building Estimates. Charles C. Wilson (T–Dec. 1.) 2000 w.

*27368. Efflorescence on Walls (I C B–Nov. 23.) 600 w.

27397. Steel Foundations of Tall Office Buildings. Ill. (Sc A–Dec. 8.) 1100 w.

27399. The Plaster Center Piece Industry. Ill. (Sc A–Dec. 8) 800 w.

27418. Failure of a Building at Montreal, Canada (E N–Dec. 6.) 700 w.

Serials.

2285. Construction. M. Viollet-le-Duc (A A–Began Feb. 1892—25 parts to date—15 cts. each).

12568. Building Construction and Superintendence. F. E. Kidder (A & B–Began May 6, 1893—36 parts to date—15 cts. each).

19078. Problems in Stone Cutting. Ill. Ed. W Hind (S–Began Jan.—9 parts to date—30 cts. each).

19218. Manhattan Life Insurance Building. Ill. (E R–Began Jan. 20—5 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (B B–Began Jan.—11 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Pl D–Began March—9 parts to date—30 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B–Began April—7 parts to date—30 cts. each).

25177. Colonial Architecture in Western Massachusetts. Ill. George C. Gardner (A A–Began Sept. 15—2 parts to date—15 cts. each).

25943. The Pernicious Practice in Selecting Competitive Plans. A. Mc C Nixon (S A–Began Oct.—Ended Nov.—2 parts—30 cts. each).

26069. Modern Steel Fireproof Construction. Ill. T. M. Small (A & B–Began Oct. 13—2 parts to date—15 cts. each).

26070. The Planning and Construction of American Theatres. William H. Birkmire (A & B–Began Oct. 13—2 parts to date—15 cts. each).

26135. Artificial Foliage in Architecture. Ill. Hugh Stannus (J S A–Began Oct. 12—5 parts to date—30 cts. each)

26838. Notes on the Great Railway Stations of London (A L–Began Nov. 2—1 part to date—30 cts).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (I C B–Began Nov. 9—1 part to date—30 cts).

26971. An American Passenger Station—St. Louis (I C B–Began Nov 9—Ended Nov. 16—2 parts—30 cts each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (A & B–Began Nov. 24—1 part to date—15 cts).

27297. Strains in Compound Framed Structures. Francis Schumann (A A–Began Dec. 1—1 part to date—15 cts).

27369 Foundations in Deep and Unreliable Soils. J. Nelson (I C B–Began Nov. 23—1 part to date—30 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering"

Maximum Practical Length for Suspension Bridges.

A FIRST installment of the report of the board of officers of the Corps of Engineers, U. S. A., directed by the Secretary of War to investigate certain bridges with a view to place in the possession of the department such information as is needed for the proper determination of questions relating to erection of bridges over navigable streams, is printed in *Engineering News* (Nov. 22). That journal justly pronounces the report "one of the most interesting and instructive of engineering documents." In its preparation most of the famous bridges in the world have been considered with reference to features applicable to special conditions that must be considered in the construction of particular bridges.

So many topics have thus been treated, that our purpose will be best subserved by selecting one of the most important as a sample of the thoroughness with which the ground has been gone over. Without doubt the topic of prime importance, as related to the question of practicable spans, is the strength of materials; though loads, foundation, wind pressure, oscillation and bracing, each formed a subject of special investigation, as directed by Gen. Casey, Chief of Engineers, to whom the report is made.

"The wire employed in the cables of the New York and Brooklyn bridge (the largest cables yet made) had a tensile strength of 170,000 pounds per square inch, and the cables were originally designed to contain each 6188 wires of No. 7 B. W. G.; but as some heavier wires were introduced during construction, the actual number of wires was only 5400." These cables have a diameter of 15.578 inches. The cables of the Cincinnati suspension bridge are 12 inches in diameter and contain each 5200 wires.

In the construction of the New York and Brooklyn bridge cables it is believed the practical limit of the number of wires that can be used in a cable was very nearly attained. This limit is imposed by the impossibility of securing in a materially larger number of wires an equal tension for each of the wires in the cable. The tensile strength of wire at present obtainable within feasible limits of cost is 180,000 pounds per square inch.

"The total cable strength available for the support of the bridge depends upon the number of cables which can be practically combined as a single cable system on one side of the bridge. If many cables are employed it becomes difficult to distribute the strains among them so that each shall carry its proportionate load under the varying conditions of temperature and traffic. It is not easy to decide what is the practical limit of the number of cables to be assembled together. Where parallel wire cables are used, they must be sufficiently separated horizontally and vertically to give room for the operation of the wire wrapping machine, and this requires intervals of at least 3 feet during construction."

Multiplying the number of cables introduces another set of difficulties. If a lateral arrangement of the cables on the saddles be adopted, "the cradling of the cables in converging planes (which is desirable for lateral stability) requires considerable intervals between the saddles." If the cables are arranged in one or more vertical planes, they must be "held the same distance apart throughout their length by suspender clamps, in which case the saddles on the towers would be closer together. Still the number of cables suspended on each side cannot be made very large without increasing the dimensions of the towers and the piers supporting them far beyond the requirements of the roadway and the suspended loads."

A vertical arrangement of the cables (or a combination of vertical arrangements) is regarded as presenting special advantages, requiring less width at the top of the towers, and affording opportunity to stiffen the bridge by a system of trusses.

"Whatever arrangement is adopted, the Board are of the opinion that it would not be found convenient to work more than eight cables together as one cable system. For the purpose of this investigation it is therefore assumed that the suspension bridge of maximum span is supported by 16 21½-inch cables."

In the course of the argument a comparison is made of the strength of wire cables, as compared with chains, and the superiority of the former is indicated. "Steel in the form of wire has a minimum strength more than double its maximum strength in the form of bars suitable for the construction of a suspension chain. A link chain will therefore weigh about 2½ times as much as a wire cable of equal carrying capacity."

The first installment of the report covers the topics of strength of materials, loads, oscillations, including wind pressures, from which in suspension bridges oscillations are set up, and the final answer to the question of maximum span is deferred till other topics bearing upon it are discussed. These, having been exhaustively considered in installments printed Nov. 29th and Dec. 6th, supply accurate data for use in the formulæ employed in an elaborate mathematical computation, which gives the result of 4335 feet as the maximum span of a suspension bridge.

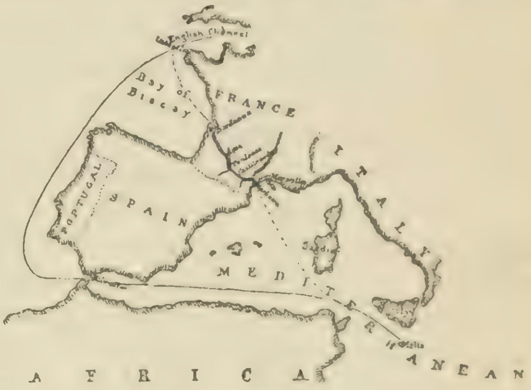
The Canal Des Deux Mers.

On the map herewith presented the present marine route from the English Channel skirting the Bay of Biscay and the coast of Spain, and thence through the Mediterranean sea, to the Suez canal, is shown by a full line, and the shorter route via the proposed ship-canal "Des Deux Mers" is indicated by dotted line. It will be seen that the distance via the canal, indicated by the heavy black line, is not very much more than one-third that of the present route.

The line of the canal itself cuts across the neck of land which joins the great Spanish peninsula to the main land, and connects Bordeaux and Narbonne.

This map, and particulars relating to the projected canal are given in the *Engineer* (London, Nov. 9), which regards the project as impracticable. However it has been vigorously urged upon the French government, the pressure having at last become so great that a third commission has been appointed to examine the scheme and report upon its feasibility.

The project has for a long time been favored, particularly in the south of France, for the following reasons. Were a ship-canal constructed on the line proposed, vessels could pass freely between the northern Atlantic and the Mediterranean without going around Spain; the French naval squadron could be united without passing under British guns at Gibraltar, and as this is regarded as being a blow at English marine supremacy that would go far toward wresting from her the title of "Mistress of the Sea," Frenchmen are strongly influenced by such a consideration. Doubtless, also, were the canal to be constructed, certain commercial advantages would accrue to districts near it; and taking these considerations all together, the fascination with which the proposal is regarded by the French people is easily accounted for.



Line of the French Canal des deux Mers

There is now the Languedoc canal connecting the Bay of Biscay with the Gulf of Lyons by which barges drawing 4½ feet of water can pass, and this fact is used as an argument for the practicability of a ship-canal. The traffic of the Languedoc canal, however is not important.

"Its construction, considering the time

when the works were carried out, constitutes one of the most remarkable engineering feats that have ever been accomplished. The scheme for constructing this canal was originated by Pierre Paul Riquet, who at the time he took up the project was a tax gatherer in the employ of the government, and the possessor of a small property in the neighborhood. Though by occupation only an exciseman, he taught himself sufficient mathematics, leveling, and surveying to enable him to lay out the line of the proposed canal, and of practical engineering to enable him afterwards to carry out the work. Having traversed the line of the canal several times on foot, examined all the sources of water supply; and had models made of the proposed locks and other works, in the year 1662, about a hundred years before Brindley began the Bridgewater canal, he laid the plans before Colbert, the controller-general of France, who was then actively engaged in endeavoring to open up new sources of wealth for his country. By order of King Louis XIV a commission was appointed to inquire into the scheme. After two months' investigation the commissioners reported it as practicable and a concession was given to Riquet to carry out the works. For the purpose of raising the money Riquet was granted the sole farming of the taxes in the provinces through which the canal would pass. This source of money however, proved utterly inadequate, and the scheme was hampered throughout the whole period of its construction by want of funds. However, Riquet with indomitable perseverance, overcame this and the other difficulties with which he had to contend, and the canal, which was commenced in 1666, was, after fifteen years labor, opened in 1681, six months after Riquet's death, and after the loss of all his property."

In 1880, a project for constructing a ship-canal with termini at Bordeaux and Narbonne, was brought forward. This scheme comprised a summit level of 525 feet, and sixty-one locks. Its estimated cost was above $106,000,000. A commission appointed, reviewing this estimate, reported it as much too small; the board of admiralty viewed the matter adversely on account of the difficulties of navigation and risks of accident, and a separate commission, considering the financial prospects as a question apart from the others, regarded them as hopeless. Thus the project was negatived on all sides, but it appears not to have been abandoned. In 1884, in a modified form, it was again pressed forward, only to be again examined by a government commission, and to be again adversely reported upon. But this has not deterred further efforts. The scheme is now again revived, and a new commission has been appointed to give it a third consideration.

The Engineer thinks "that after the reports which have been issued by previous commissions" it will be "a mere waste of time and money to make further investigations," and that, although the engineering features present no insuperable difficulties, yet, on the face of it, the scheme must be considered as financially impracticable." Criticisms of the features of the work, as now projected, include, among other things, an assertion that the sectional area of the canal is too small in proportion to the midship section of a large steamer, to allow passage except at a very low rate of speed.

Landslides.

Of landslides, one of the worst difficulties encountered in railroad engineering, Mr. David Molitor gave the results of what seems to have been a very exhaustive study, in a paper read before the Association of Engineering Societies and printed in *The Railway Review* Nov. 24. The paper was accompanied with numerous illustrations of typical landslides as they occur with different materials, and contains a thorough analysis of the conditions which in the different materials produce the sliding. In dealing with this part of the subject a good classification of landslides is made, which arranges them in four groups. "A. Those occurring where the slope is too steep to maintain equilibrium of the mass. B. Those caused by inclination of the natural strata, combined with the lubricating action of water.

this and in the previous case we find a learly defined sliding surface. C. Slides aused by the action of water alone. Here he material is softened to such a degree at it becomes fluid. D. Where the nderground is not capable of supporting he weight of the overlying fill material."

The best means of prevention are dis- ussed in due order with the different roups; but it is avowedly the author's ain purpose to lead up "to a new method f finding the earth pressure . . . . as a tep in advance of what has been previ- usly done toward getting at the bottom f this matter. It is vain to expect to rrive at such results when dealing with ch material as earth. The best we can ver hope to do is to approximate to e truth. It is also useless to experiment ith dry earth, for nowhere in nature do e find large masses of earth in a dry tate. An embankment constructed from bsolutely dry sand would in a short time bsorb moisture, and thereby assume en– rely different properties. Of all experi- ents made, or to be made, those only are aluable which are made under the actual onditions existing in nature, and of these e will find the extreme cases most valu- ble. All engineering structures should be o designed as to comply with the most nfavorable conditions which may at any me occur, and this in itself is sufficient eason why experiments and investigations hould be made under corresponding cir- umstances."

Some examples of landslides occurring ith Opalinus and Turneri clays on a Ger- an government railroad in a portion hose construction was under his charge, re cited by Mr. Molitor. These clays disintegrate into a fine powder which, hen wet, presents all possible properties bjectionable to the engineer." But these ndslides were made serviceable in secur- g experimental data, being taken advan- ge of for this purpose as experiments on large scale with special materials.

"Whenever a slide occurred, accurate oss-sections were taken and plotted the original sections taken for the oject. The general method of repairing ese slides consisted in cutting vertical passages into the sliding slopes and filling them with rip-rap. In the course of such repairs the sliding surface, or surface of rupture, became exposed, and could be plotted on the corresponding cross-sections previously taken, thereby making a complete record of all the conditions attending the slide. The slides which are here referred to, and which prompted the following conclusions, were all caused by depositing material at a steeper slope than it could maintain.

"Numerous slides occurred also in the cuts through these clays, and although the slopes of such cuts were quite stable at first, yet it was easy to see that at some future time, when the material disentegrated, it would act precisely as it did in fills. It would follow directly from this fact that the slides which occurred in cuts would not present the same features as those in filled earth; and in making experiments we must remember that filled earth exerts the maximum pressure, whereas the very same material, in natural strata, may, after cutting, at first exert no pressure at all." This is explained by the fact that the material, in its natural layers, is more compressed or compacted than it will ever be after it has been dug up and moved about.

As the result of observations on these landslides, the following propositions are made in conclusion. "1. That what is commonly known as the angle of repose of a certain material, is not a constant angle but a variable, depending upon the vertical height of the slope. 2. That what is called the plane of rupture, is not a plane but a curved surface whose cross-section closely approaches the form of a hyperbola. 3. That the surface of repose, as would follow from proposition 1, is not a plane, but a curve. For practical purposes, however, we may use an average straight line for the slope.

"These three propositions, although they were determined only from experiments on Opalinus and Turneri clays, seem to be true for all materials, except that the relation of the height of slope to the angle of repose, and of the degree of curvature to the surface of rupture, vary for different materials. It may be that the angle of repose varies less rapidly for sand than for clay, but we have no experiments on large sand embankments to verify this supposition. It is also possible that, for sandy material, the surface of rupture approaches more nearly to a plane, but all known experiments have been made on so small a scale that the conclusions become erroneous when applied to large masses."

Effects of Stress on Corrosion of Metals.

EXPERIMENTAL investigations upon the general subject of corrosion of metals have been much needed. The phenomena of corrosion have not been studied with that thoroughness which their importance demands. Mr. Thomas Andrews, however, presented before the Institution of Civil Engineers, at a recent meeting of that body, a series of researches which ought to set the pace for a complete elucidation of the causes which effect the chemical destruction of metals as used in modern structures, and the influences that act to retard or accelerate this action.

One of the lines on which Mr. Andrews has extended his investigations is the influence of stress upon corrosion; and contrary to what would probably be the general opinion in advance of experiment, this is found to retard rather than hasten the result.

The iron and steel upon which experiments were made were selected from standard samples. *Engineering News* (Nov. 15), has given a good account of the method employed.

"The specimens tested were large, rolled, wrought iron bars; wrought iron, hammered shafts; Bessemer and open-hearth forged, steel shafts and large bars of soft and hard Bessemer steel, soft and hard cast steel and aluminum, nickel, chromium, silicon and copper steel. Experiments were also made on rolled plates of wrought iron, Bessemer and open-hearth steel, and soft cast steel. The chemical composition and general physical properties of these specimen metals are fully set forth in tabular form in the original paper.

"The author estimated the relative corrosion of the 'strained' and 'unstrained' portions of the same metals by the galvanic method which he introduced some years ago with satisfactory results in his previous researches on the corrosion of metals. By means of the exceedingly sensitive galvanometer the slightest variation in the relative rate of corrosion between any two metals, immersed in an electrolyte, can be ascertained. In observing the influence of tensile stress upon the corrosibility of iron and steel bars, the following method was pursued:

"From each metal under investigation a bar was cut and turned into a test piece 6 inches long, 3 inches between heads, ¾ inch in diameter for this 3 inches and 1 inch and 1½ inches in diameter for the heads, each ¾ inch long. This bar was then submitted to a stress usually sufficient to produce an elongation of 20 per cent. between gage points 3 inches apart. After being strained, the piece was cut in two at the center, and both halves were turned down to exactly the same dimensions. In one piece the 'strained' end coincided with the middle of the test bar, and was left untouched in the lathe up to the point where there was any reduction in diameter, caused by the tensile stress. In the second half, the end corresponding to the 'strained' end of the first half was turned out of the head of the test bar, and this end thus consisted of 'unstrained' metal, or at least of metal considerably less under the influence of stress than the end of the first half.

"These two halves exactly alike in form, were then immersed, as a galvanic couple, in a saturated solution of sodium chloride, and sometimes in sea water. They were held in position in the beaker by insertion through two holes in a plate of thick glass, with the tapered ends only immersed to a depth of about ¾ inch in the solution. Galvanic contact between the two pieces of metal was only made momentarily at the time of reading the galvanometer, and the differences of potential between the 'strained' and 'unstrained' metals were thus observed. The terminals of the bars were connected with a delicate galvanometer, placed in a circuit, with results fully abulated in the paper of Mr. Andrews for ach set of experiments. A sensible current was observed between the two bars, nd the 'unstrained' end was found to be n the electro-positive, answering to the inc in a galvanic couple. This indicated hat the 'unstrained' metal was being more apidly acted upon by the solution, and vas thus corroding more rapidly than the strained' metal."

The conclusions reached are, that steel corrodes more rapidly than iron when exposed to sea water; that corrosion ncreases in such exposure as the per centge of carbon increases, that galvanic ction as set up between iron and steel greatly promotes corrosion, and that stress cts to resist corrosion, all of which are important contributions to, or confirmations of, previous knowledge of this class of phenomena.

Solid Metal Bridge Flooring.

THE subject of solid metal bridge flooring is just now, and is destined to be in the future, one which bridge constructors must consider with a view to the selection of best types of construction, cost of erection, etc., since such flooring is now, and will continue to be, demanded for bridges crossing over streets in cities. Those desiring to get abreast with current opinion regarding the various types of solid metal flooring in use or proposed can find a good exposition of the requirements in a paper by Geo. B. Francis, M. Am. Soc. C. E., in *Engineering News* (Nov. 15).

"Three matters of prime importance in connection with bridge floors are being brought to the front very rapidly, and engineers will be obliged to give serious attention to them whether they wish to or not. 1. City ordinances and court decrees are going to specify 'solid metal, water-tight, ballast floors,' wherever tracks are to be carried over busy, city or village streets. Solid metal, because timber is inefficient; water-tight, because of the drip nuisance, and ballast floors to reduce noise to a minimum. 2. Such a provision is incomplete without a carefully-devised system of drainage gutters and conductors. 3. Such a solid floor must be selected as will suit the individual case to be met."

A bridge floor on Archer ave. Subway, Chicago, Ill., described and illustrated in *Engineering News* (Oct. 11), which is on a through girder bridge having floor troughs with four continuous joints in the bottom of each, is cited as a "typical example" of such a bridge, in which "the question of ballasts, style of floor and drainage have all received consideration," the result being "a finished design, whatever may be said of the final settlement of each question." Such a floor "is all right, provided an engineer can satisfy himself that the four continuous joints . . . to which water has access, are going to prove water-tight after some time in service, or after the expense of calking or other treatment to make them so has been borne."

This kind of flooring would not answer for a deck-girder bridge, being only adapted "for a floor that is hung in some manner; and for deck flooring a shape with flat tops and bottoms and inclined sides would be more suitable." A reason for regarding this form as more suitable, is the tendency for a rectangular shape to deform under load, whereas the "flooring with inclined sides" is free from this defect.

"It is also perfectly feasible to use the latter flooring where the bridge must be made with through girders, either by resting the flooring directly on the bottom flange of the girder or by cutting short the bottom member and resting the flooring on clips or shelf angles under the top member."

In such a construction proper provision for drainage must be provided, a suggestion for which is a drainage hole "punched in the shapes to take the water clear of the flange.

"It would seem that a floor with the bottom member made up in one piece, trough shape, would be more liable to give satisfaction for conveying water than one which has joints in the base, or which allows a ballast load in the trough to pull on the rivet heads, to say nothing of a saving in bottom flange metal and general economy due to sloping sides. It cannot be denied, however, that floors of excessive depth, say about 16 inches, suitable for double track width, can be better made up of vertical webs; but it is questionable if excessively deep floors are desirable.

With reference to noise, the pavement under the bridge is a potent factor, and to get good results something like asphalt is required, a material that will make a comparatively noiseless pavement.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

26865. Experience with Solid Metal Bridge Floorings. George B. Francis (E N–Nov. 15.) 1300 w.

26871. A Novel Detail for Suspension Bridge Cables. Ill. (E N–Nov. 15.) 1900 w.

26929. Mussy Viaduct—Paris, Lyons and Mediterranean Railway. Ill. (R R–Nov. 17.) 900 w.

*27344. Ruthven Bridge, Kingussie. Ill. (I & I–Nov. 23.) 900 w.

27398. The Roman Bridge in Mostar. Ill. Sc A–Dec. 8.) 400 w.

Canals, Rivers and Harbors.

*26657. The Drainage System of the Valley of Mexico. A Vast Engineering Accomplishment. M. Romero (E Mag–Jan.) 4000 w.

*26700. Canal Traffic in France (C G–Nov. 2.) 3000 w.

26823. The Proposed Deep Waterway from the Great Lakes to the Ocean. Wendell L. Simpson (Sc A S–Nov. 17.) 4000 w.

†26843. The Rivers of Central Asia. Ill. E. A. S. (I E–Oct. 13.) 2200 w.

26856. From Lake to Gulf. Douglas Wolworth (T–Nov. 15.) 1800 w.

26864. Earth Excavation in Section I and K, Chicago Drainage Canal. Ill. (E N–Nov. 15.) 1500 w.

*26952. The French Canal des Deux Mers (Eng L–Nov. 9.) 2300 w.

*27014. French Canals and Canal Traffic (Tr–Nov. 9.) 3600 w.

27019. The Construction of a Concrete Wharf at Portslade. Ill. Joseph Cash (E N–Nov. 22.) 600 w.

27140. The Locks at the Ends of the Canal Between the North and Baltic Seas. Ill. (Sc A–Dec. 1.) 700 w.

*27244. Great Canals. A. G. Menocal (Ch–Dec.) 4000 w.

*27379. The Inclined Planes of the Morris Canal. Ill. (A E R J–Dec.) 2500 w.

27422. Nicaragua Ship Canal. Ill. Alex. D. Anderson (M R–Dec. 7.) 1000 w.

Hydraulics.

*26733. Hydraulic Capstans. Ill. Arthur Rigg (P Eng–Nov. 2.) 2500 w.

26869. Diagram for Discharge of 2 to 7 ft. Brick Conduits Flowing Full. F. S. Bailey (E N–Nov. 15.) 350 w.

*27260. On the Utilization of Water for Power and Transmission of Same. John Ritchie (C G–Nov. 23.) 5000 w.

27359. The Capture of Niagara. Ill. (From McClure's Magazine) (T–Dec. 1.) 3000 w.

Irrigation.

*27269. The Utilization of the Nile. Editorial (Eng L–Nov. 23.) 1200 w.

*27372. Egypt and the Nile. (Abstract.) Colin Scott Moncrieff (I C B–Nov. 23.) 3000 w.

Miscellany.

26899. Repair of the Moline Wall. Ill. Charles Francis (E R–Nov. 17.) 1100 w.

26918. The Effect of Stress on the Corrosion of Metals. (Abstract.) Thomas Andrews (E N–Nov. 15.) 1400 w.

*27050. On Waterworks Construction and the Use of Concrete and Earthwork in Forming Embankments. William Watts (C G–Nov. 16.) 4000 w.

27135. Landslides. Ill. David Molitor (R R–Nov. 24.) 4000 w.

†27233. Some Tests of the Strength of Spruce Columns. Gaetano Lanza and Edward F. Miller (A S M E–Dec.) 500 w.

27413. Enlarging a Tunnel in Soft Ground. Ill. (E N–Dec. 6.) 900 w.

Serials.

22670. The Iron Gates of the Danube. Bela von Gonda (Eng L–Began June 1—4 parts to date—30 cts. each).

25858. The North River Bridge—Appendices (E R–Began Oct. 13—5 parts to date—15 cts. each).

26048. West India Dock Improvement Works. Ill. (E–Began Oct. 12—Ended Nov. 9—3 parts—30 cts. each).

26914. Waterways vs. Railways—Deep Water Routes to Connect the Great Lakes and Rivers with the Ocean (R A–Began Nov. 16—3 parts to date—15 cts. each).

26998. The Chicago Drainage Canal. Ill. (E–Began Nov. 9—Ended Nov. 16—2 parts—30 cts. each).

27020. The Maximum Practicable Length for Suspension Bridges (E N–Began Nov. 22—Ended Dec. 6—3 parts—15 cts. each).

27032. Sundry Engineering Matters Considered in the Construction and Operation of the New York and Brooklyn Bridge. Ill. (R G–Began Nov. 23—Ended Dec. 7—3 parts—15 cts. each).

27071. Graphic Method of Taking Out Areas, Banks and Cuttings. Ill. R. E. (I E–Began Oct. 27—1 part to date—45 cts).

DOMESTIC ENGINEERING

Bacteriology of Sewer Air.

WHILE it is most generally admitted that disease germs are transmitted by sewers, there has been much difference of opinion relative to the precise manner in which diseases—typhoid fever, for example—are conveyed from one point to another at a considerable distance. The difficulty in fixing upon a precise way in which these germs gain access from sewers to the atmosphere in inhabited dwellings, has led to some skepticism that this actually takes place, as believed by most sanitary authorities. The question may perhaps be regarded as still unsettled; but experimental research, the only way in which a solution of it can ever be reached, is in active progress.

Among the most notable of these researches are those conducted by David Arthur, M. D., Demonstrator, Laboratory of State Medicine, King's College, London, the results of which were communicated to the recent Sanitary Congress, and were printed in the *Sanitary Record* (Nov.10, 1894).

The researches of Dr Arthur were directed to sewer air at the ventilators, for the reason that sewer air existing midway between two ventilators, which is the air hitherto principally examined, contains, "roughly speaking, only half the number of micro-organisms that are found in the external air at the same time." From this fact observers have argued that the micro-organisms must have come from outside air; that the damp walls of the sewer would act like a Hess's tube, and so account for their diminished number. "No doubt such is the case; but being, however placed in such a moist trap as a sewer, it is a matter worthy of consideration how it comes about that the sewer air contains even so many micro-organisms, when it is taken into consideration that the air gently drawn through a common Hess's tube is sterile. This can be best explained after noting the condition of sewer air at the ventilators." Dr. Arthur claims that his observations are the first that compare the bacteriology of ventilating air of sewers and outside air.

"Here invariably, when the ventilator was acting as an outlet, I found more micro-organisms in the exit ventilating air than in the sewer air, and if there had been rain recently, many more even than in the outside air; and vice versa, if the ventilator was acting as an inlet. I invariably found more micro-organisms at the bottom of the ventilator than were present in the outside air.

"This increase of micro-organism was the first means of making me suspicious of the deductions of past observers, and made me incline to believe that, after all, the sewer *did* give off micro-organisms. Naegel asserts that 'slight upward air currents are enough to prevent floating bacteria from settling down. The condensed watery vapor that surrounds them tends to maintain their buoyancy.' So the constant deposition that takes place in a horizontal sewer will be stopped when it reaches the exit ventilator, and at the exit will be found the number of micro-organisms present in the air, plus what was given off from the ventilator wells. But in the sewer itself there would be no increased collection, as the micro-organisms would be deposited in the same section of the sewer where they were given off.

"With this theory, then, there is a continual deposition and a continual elimination of micro-organisms, the balance being the number found. This theory accounts for the small number found in sewers and the greater number found in outlet ventilators; not only so, but makes it clear how past observers could not in many cases explain their results."

To test whether and how micro-organisms were given off from sewers, he performed the following experiments, based upon the proposition that "micro-organisms are being continually deposited and continually given off."

"A large tube, 5 feet 5 inches long and 2¾-inch bore, was plugged at one end and partly filled with water, and gently rotated in the horizontal position. A Frankland's tube was put through the gutta-percha stopper, and 15 liters of air aspirated. This air was found to be practically sterile. The tap water was run out, and fresh sewage substituted for it. Still the 15 liters of air that were aspirated from over the fresh sewage were practically sterile.

"Now the micro-organisms and molds collected from about twenty sewer-air experiments were placed in the tube along with a little sewage ¾inch. Four days later, when there was a liberal growth of molds, 15 liters of air were aspirated from the surface of the molds and sewage, when there was found a large number of micro-organisms. This experiment was confirmed several times, both with Frankland's method and with Sedgwick and Tucker's tube. Again, I confirmed these experiments in another method, by aspirating air through sewage.

"It was found that by aspirating 10 liters with gentle bubbling, 3 organisms were found; 10 liters with violent bubbling, 6 organisms were found; 11 liters over fresh sewage, 3 organisms were found; 10 liters over broken dried sewage, innumerable.

"Again, I had two flasks one-third full of broth-culture connected by a brass tube about quarter-inch bore. This tube had a siphon bend upon the portion between the flasks and each end of the tube dipped beneath the surface of the broth. Into each flask there was put a bent air-pipe, plugged at the external end with cotton wadding. All the joints were covered with beeswax and vaseline. The contents of the flask were sterilized by boiling for five minutes during three consecutive days. The trap connecting tube was coated with organic matter by pouring the broth from one flask to the other. After the contents of the flask were cool, and the trap full of the nutrient broth, one flask was inoculated with typhoid bacilli, and the whole placed in the incubator.

"In three days the contents of the inoculated flask were cloudy. After twenty-one days the fluid in the trap became cloudy, and seven days later the fluid in the second flask also became cloudy. Drop and cover glass preparations were made from the latter, when the typhoid bacillus was found in abundance.

"This in my opinion is one of the principal ways sewage microbes find access to sewer air. The bacteria of the sewage may creep like those of typhoid up the walls of the damp nutrient sewers, so that they may be literally alive with them. Molds here also grow with great proliferation. In their struggle for existence they will often be covered with bacteria, and in shooting forth their spore stalks must carry some bacteria out with them. When the spore heads are sufficiently long to project from the damp sewer walls, and have become ripe for dissemination the clinging bacteria and their spores will become liberated mold-spores, and bacteria, or their spores, will be wafted with every air current; many will gravitate to the sewage; others will stick to the damp sewer walls; others will be carried up the ventilators to the outside air; while others, again, may gain access to dwelling houses."

Confirmatory opinions of a number of scientific authorities are quoted to support these views; and these also sustain the opinion that sewer air in contact with such infected material becomes imbued with specifically contagious properties. As to the identity of these organisms respectively isolated from external air and from sewer air as alleged by previous eminent investigators, the experiments of Dr. Arthur afford a striking confirmation.

Transplanting Trees.

A VERY important part of arboriculture is the transplantation of trees. Many things are necessary to be observed in order that this operation may be successful, even for small trees, and this is all the more true, when adult trees are to be transplanted, as is frequently done for adornment of parks and ornamental grounds. With reference to transplanting deciduous trees after the 1st November in the latitude of New York, an answer is given to inquirers in *Garden and Forest* (Oct. 31). It is not enough that a tree shall have vitality left to put forth its leaves after transplanting. Nothing less than "an unshattered constitution, a vigorous life, a promise of longevity, and conditions which insure its best development in size, beauty and in characteristic expression" will satisfy an enterprising planter.

"Small trees can be moved successfully at any time of year by one who knows just how to do it. But in this latitude the transplanting of trees ought not to be postponed until as late as the middle of November. Certainly, no tree ought to be transplanted after this date unless the ground has been thoroughly and intelligently prepared beforehand. If trees must be dug or purchased now, it is better to heel them carefully and at once begin to prepare the place where they are to live permanently.

"We have often explained why a large pit should be excavated for a tree. A wholesome tree needs a great deal of food, and it must stand in a soil whose texture will make that food available. Where trees are to be planted in groups the whole ground should be trenched to a depth of two feet, and for a single long-lived tree an excavation which is ten or fifteen feet across and three feet in depth is none too spacious. The surface-soil should be placed to one side and the stones removed from the hardpan. This subsoil should be returned to the pit, and it will be all the better if a little rich soil and peat can be mixed with it, and then the surface-soil should be placed on the top as before. During the winter all this will settle and become firm, while the action of the frost will reduce the size of the particles. Next, spring the trees can be lifted and placed in a small hole made in the center of the large one, care being taken as the roots are covered to ram the ground tightly about them. If we wait till spring to dig these holes, or if the tree is planted in them now when they are freshly dug, the soil will settle away from the roots as the tree sways in the wind, or the rain will wash it away, leaving air-spaces about the roots, which are fatal to the tender feeding fibers already formed, and which offer no encouragement for others to take their places. If the trees are properly heeled in a sheltered place to prevent evaporation, a sufficient number of roots will form to keep the branches plump during the winter; the scars, where bruised roots have been cut away, will have become calloused over, and they will suffer no shock when removed to their abiding place in spring, but will continue to grow as if they never had been disturbed. If trees are to be brought from a distance it is, therefore, better to procure them in the autumn than to wait until spring, and everything will be at hand for prompt action at a time when work of many kinds is pressing. If it is too late to secure the trees in time to heel them in while the ground is still warm and open, they should be procured at once and wintered in a cellar or pit. If they are heeled in they should be placed in a rather shallow trench and in an inclined position, and far enough apart to allow fine soil to penetrate every portion of the space occupied by the roots without leaving any unfilled interstices. The ground of course should be dry and well drained; no stones, clods or sods should be used in the filling, nothing but finely pulverized soil. A portion of the stems, as well as the roots, should be buried and the surface rounded, and it is better to dig a trench around the whole area occupied by the tree-roots, be-because mice will not be liable to push up under the snow against an inclined bank of earth."

An argument is made for the strict observance of the method described, and the rationale of the directions is discussed. That these directions are not generally well known, and where known are not sufficiently heeded, is regarded as accounting for the frequently unthrifty condition and numerous failures of transplanted trees. Unless a tree "be fed and made happy in its new surroundings, as systematically and judiciously as if it were a growing animal, the result will be a lasting disappointment and regret." No part of the art of landscape gardening requires greater care and attention to details than transplanting trees.

Climbing Plants on Boston Buildings.

THE use of climbing plants in mitigation of bad architecture, as exemplified in Boston, is made the subject of an interesting article in *Garden and Forest* for November. "Probably nowhere else in this country does the service performed by climbing and clinging plants in clothing and adorning the walls of buildings receive such good illustration as in and around Boston. Ampelopis tricuspidata was first domesticated here, and has so long been a striking feature of this city as to gain for it throughout the country the familiar name of "Boston Ivy." This name, however, is seldom heard here, where it is most commonly known as the "Japanese Ivy" or the "Japanese Ampelopis."

The Museum of Fine Arts in Boston is cited as a remarkable example of the effect of this creeper in concealing architectural defects. "It clambered bravely over the ugly walls of the parti-colored terra cotta and brick, and for awhile so nearly effaced the unspeakable reliefs of the second story as to give them the charm of indefiniteness. But the trustees have since restricted the creeper to the first story."

Another conspicuous example out of many which are cited is the "Old South Meeting House, where it creeps over an enormous expanse of gray old walls and high up on the tower, relieving the severity of the Puritan architecture." The old gateway of the Granary burying ground, adorned by this creeper, has been spoken of as one of "the most beautiful things in all Boston." Of the value of trailing growths for fences in parks and grounds there cannot be two opposite opinions, but it is not fully appreciated.

"In Germany the Virginia Creeper is put to simple and effective use for this purpose in urban public grounds. A light low fence is made of stakes and connecting wires; the Virginia Creeper is trained up each stake and made to form graceful festoons between. Its employment in some fashion would do good service on a place like the Cambridge common, for instance, now a bare, unattractive expanse, having a sort of kinship with the New England rustic burying-ground. It is surrounded by a fence composed of unhewn granite posts with squared rails of wood between. Virginia Creeper, Japanese Ampelopis, and perhaps other twining or climbing plants, might convert this old fence into a thing of beauty. In public parks the requirements for protection of the borders sometimes necessitates guards of wire and stakes along the paths. These are often great disfigurements, and their offensive aspect, in places where they seem to be required permanently, might be at least mitigated by the use of Virginia Creeper after the German fashion."

Another climbing plant said to be "coming into marked favor is the Evonymus radicans, from Japan." English ivy is not thoroughly hardy in and around Boston, though considerably used.

Combination Heating.

MR. GEO. HOFFMAN writing upon this subject in the *National Builder*, regards the system of heating by the use of hot water or steam, and heated air as "here to stay," and enumerates certain advantages claimed for this method. Perhaps for the general reader, it may be well to say that in this system, air brought in fresh from the outside of a dwelling through pipes or ducts (usually called in heating specifications the "cold air boxes") is heated by a furnace in the usual manner, and is conveyed through warm air pipes to parts of the building where it may be circulated with ease and certainty; while parts so located that it is difficult to get the warmed air to them by simple flow through pipes are warmed by steam or hot water. The steam or water for this purpose is usually heated by the same furnace, which is specially constructed with a heating coil or a steam generator for this purpose. In warming larger buildings, used as schools, etc., a separate furnace for heating air, and a boiler for supplying radiators with hot water or steam are sometimes used, but this would not, strictly speaking, be known in the heating business as a combination system, the term being confined to systems wherein the same heating furnace supplies heat to different vehicles for conveying warmth to the apartments to be heated.

"Air will absorb heat much more rapidly than either liquids or solids and as in combination heating we are depending for fully fifty per cent. of our warmth on air-heat, the natural conclusion is that a combination heater will give results in the rooms to be heated much quicker" than either steam or hot water used singly. Of course it will be understood that very good ventilation may be attained in this way by a well constructed apparatus.

American Society of Heating and Ventilating Engineers.

MANY suggestions for the Advancement of this new association are contained in *Heating and Ventilation* for November. These have been supplied in response to an editorial request for such suggestions, made with a view to place the association on a high plane of usefulness, and to make it equal in all respects to other high-class engineering associations. The association was organized last summer, the project having been favorably regarded by leading houses in the heating trade. The contributions of practical suggestions under notice come from good sources, and show that the formation of such a society may conduce largely to the benefit of this branch of the engineering profession. The organization seems to be regarded as having started under favorable auspices, and has given already much encouragement to those who initiated the movement. One cannot read these suggestions without arriving at the conclusion that an organization of this kind is needed; and the hope that its future may be as brilliant as its advent has been timely and auspicious.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

26421. The American Society of Heating and Ventilating Engineers. Suggestions for its Advancement (H & V–Oct.) 5000 w.

26789. Combination Heating. George Hoffman (N B–Nov. 10.) 1300 w.

26855. Ventilators (A An–Nov. 15.) 1200 w.

26861. Heating the Rosary Hill Convent. Ill. (Met W–Nov. 17.) 1200 w.

26904. Unusual Piping in a Hot-Water Heating Apparatus. Ill. (E R–Nov. 17.) 600 w.

26905. Modern Residence Heating Plant. Ill. (H & V–Nov. 15.) 3400 w.

26906. Warm Air Heating. Ill. (H & V–Nov. 15.) 2200 w.

*26916. Practical Suggestions Respecting the Ventilation of Buildings. John H. Kellogg (D E–Nov.) 5000 w.

27277. Defective Heating Boilers and Fittings (B J C–Dec. 1.) 900 w.

*27370. Domestic Boiler Explosions. Ill. J. Walker (I C B–Nov. 23.) 1500 w.

27419. Explosion of a Cast Iron Steam Heating Boiler. Uxbridge, Mass. (E N–Dec. 6.) 900 w.

Landscape Gardening.

26322. Transplanting Trees (G & F–Oct. 31.) 1200 w.

26779. The Pinetum at Wellesley. Ill. (G & F–Nov. 14.) 1300 w.

26780. Gardening at Newport (G & F–Nov. 14.) 1400 w.

27154. Accumulation without Disposition. M. C. R. (G & F–Nov. 28.) 1300 w.

Plumbing and Gas Fitting.

*26665. Plumbing Trade Schools and their Influence.—How they Promote Sanitary Science. E. N. G. Le Bois (E Mag–Jan.) 3000 w.

*26915. The Plumber's Relation to His Client and the Community in which He Lives. William P. Moffat (D E–Nov.) 1500 w.

Miscellany.

26909. Suggestions for the Advancement of the American Society of Heating and Ventilating Engineers (H & V–Nov. 15.) 2500 w.

Serials.

26907. Hot Water Heating and Fitting. J. L. Saunders (H & V–Began Nov. 15—1 part to date—15 cts).

26917. Combination Heating. By a Practical Furnace Man (D E–Began Nov.—1 part to date—30 cts).

26969. The Teaching of Plumbing Apprentices (I C B–Began Nov. 9—Ended Nov. 16—2 parts—30 cts. each).

27047. The New Rain Bath of the Utica State Hospital. Ill. William Paul Gerhard (E R–Began Nov. 24—Ended Dec. 1—2 parts—15 cts. each).

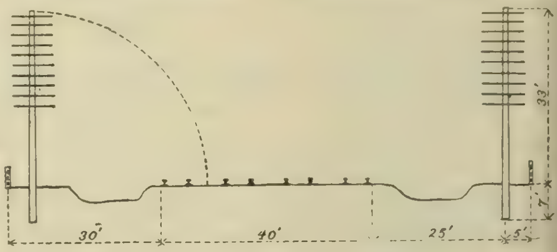
27214. Combination Heating. J. W. Hughes (Met. W–Began Dec. 1—1 part to date—15 cts).

We supply copies of these articles. See introductory

ELECTRICITY

Telegraphic Engineering and Construction.

ATTENTION was directed, in some remarks made in this department last month, to certain dangers due to the overloading of telegraph poles with wires—a practice which has become far too common on many of the principal routes of intercommunication in this country. Referring to this matter in its issue of November 10, the *Railroad Gazette* expresses the opinion that "the Western Union Telegraph company, like some railroads, has in many places devoted its energies to cheapening rates when it ought to have devoted them to improving the service." The *Gazette* further suggested that every railroad might at least have the poles set far enough from the track to avoid danger to trains in case a pole falls over. A correspondent, writing in the same journal of December 7, says: "I have long felt that the gigantic poles erected along the tracks of our trunk lines, and daily growing weaker, were a constant menace, to ignore which was to invite disaster. While it may not be practicable, at the present time, to force all poles back, as you suggest, we can and should insist upon rigid inspection, and the renewal of any pole showing signs of weakness." The same contributor—who is an executive officer of one of the principal New England railroads—states that but for the good judgment exercised by the men in charge of a fast freight on his road on the night of November 5, a disastrous wreck would have occurred from this cause. What this official says in reference to the dangers of the present situation is all true, but the evil is one which at best can only be partially guarded against by the most rigid inspection. A somewhat extended series of observations has led to the conclusion that it is impossible to construct a telegraph line according to present methods, carrying from 50 to 100 wires, in which the poles are not liable to give way, either by breaking off at the ground line or being pried bodily out of the earth, when the wires are heavily loaded with sleet or snow. A forcible example of this kind was noticed last winter, on the Lowell division of the Boston & Maine railroad at a point a few miles out of Boston, where a deep cut was literally filled for a quarter of a mile with the wreckage of an overthrown telephone line of very heavy and almost new poles carrying a large number of wires, but otherwise constructed in the best possible manner, causing a blockade of trains for a considerable time. Moreover it is seldom practicable to set the poles far enough away from the tracks to avoid the danger, as will clearly appear from the accompanying diagram drawn to scale, which illustrates a condition of affairs not at all uncommon in practice. The remedy, to be at all effectual, must be a radical one. The overhead lines along the railroad rights-of-way must be restricted to a safe number of wires, and when it becomes necessary to exceed this number, as in practice it often must, then resort must be had to underground construction. The alternative course, as we pointed out last month, is for the telegraph company to secure a right of way of its own between such cities as New York and Boston, or New York and Philadelphia. Three rods in width would be ample to provide space for all the lines likely to be needed for the next fifty years, and as the route could nearly all the way be carried through uncultivated land, the land damages would not be likely to exceed $30 per acre, or say $40,000 for the entire route between New York and Boston; by no means an onerous amount. In the immediate vicinity of large towns, undoubtedly some underground construction might



TELEGRAPH POLE SETTING.

e required, but the plan as a whole is en-irely feasible, and ought to receive imme-iate consideration. There is no good eason why a telegraph line, any more than railway, should be a mere tenant by suf-erance, and dependent upon the good will f other corporations for its rights of way. Such a policy was very well so long as the umber of wires required was not great nough to incommode or endanger the rdinary and legitimate uses of streets, ighways and railways for purposes of rade and transportation, but in view of he unavoidable multiplication of wires at he present day, there would seem to be rgent need of some radical reforms in ex-sting methods.

Electric Power on the Farm.

DURING the past three or four years there has been a considerable amount of talk, specially in the prospectuses of "fake" lectric railroads and in the pages of popular agazines, of supplying electric power to armers, especially those situated along the ine of electric railways. It seems how-ver, from an article in the *Street Railway eview* (November) that a promising eginning in this direction has already een actually made. The Crystal Hill arm and dairy, near Catasauqua, Pa., andles a large amount of corn-fodder and nsilage, and is provided with silos having n aggregate capacity of over 1000 tons. he expense of preparing the ensilage by orse-power was found to be very great nd this led to the substitution of steam-ower. An engineer had nevertheless to e employed, and all the coal used hauled long distance by team, so that although team proved to be cheaper than horse-ower, the expense was still considerable. n the fall of 1892, an electrical contractor f Catasauqua induced the proprietors of he farm to try electricity. A 220 volt cir-uit 2½ miles in length was extended from he terminus of the lines of the local light-ng plant, and a 5 horse-power direct-cur-ent motor was installed at the farm, which erved to operate the churns, cream-eparator, bottle-washer and ventilating ans during hot weather, while the same ircuit furnished abundant electric light to all the farm buildings. This experiment proved so successful that the 25 horse-power steam-engine was soon afterwards replaced by a 10 horse-power motor of the same type as the first. The motor soon demonstrated its superiority over the steam-engine for the particular class of work it was called upon to do. Seventy head of milch-cows are fed on ensilage during the year, for which the adoption of the electric motor has reduced the cost of preparing the ensilage from $1.50 to 80 cents per ton. Threshing, wood-sawing, etc., are performed by the same power. In the same region, the Allentown stock farm of Hon. J. Roth has installed a 15 horse-power direct-current motor which takes current from the trolley line of the Allentown & Lehigh Valley Traction Company by a specially constructed single-wire line 3300 feet in length. The current is sold by meter at 8 cents per kilowatt hour. The motor is placed in a building back of the barn, and belted to a main shaft supplied with pulleys for operating various kinds of farm-machinery. Threshing, cutting feed, grinding grain, shelling corn, pumping water, sawing wood, etc., are done in this way. A barn 50 by 208 feet is also supplied with electric lights. Mr. Roth says that he finds that electricity is not only much cheaper than steam or horse-power, but that it is far more convenient and more safe. He is strongly recommending other large farmers in his vicinity to adopt it.

The Architect and the Electrical Engineer.

THE Interdependence of the Architect and the Electrical Engineer is the topic of a thoughtful article by Professor F. A. P. Perrine, in *Electrical Engineering* (November). The author thinks that the reluctance of architects to undertake the study of the details of electric lighting systems has been largely responsible for the slow progress of electricity in the household. He points out that the problem of lighting any one of the larger class of office buildings now existing in half a dozen of our chief cities, is not inferior in importance or difficulty to the problem of furnishing light for a town of six or eight thousand inhabitants. An architect who undertakes to make plans for such a building ought to make himself familiar with the design, construction and maintenance of a very considerable central station for supplying it with light. Then there are the questions of telephone and signal service, of electric elevators, and so on. "Shall we say then"—says Professor Perrine—"that either our architects must become one of the electrical profession, or that it will be necessary for the electricians to study architecture? Both these propositions seem to ask for more ability and diversity of training than should be expected of one man in either profession." The best solution of the problem, the author thinks, is to be looked for in the direction of a better mutual understanding between the architect and the electrical engineer when working together upon the same design. "It should not be necessary for the electrician to search in vain on the plan for space in which to run his wires. The architect should understand the reasonableness of fuse-wires and junction-boxes, and he should be capable of understanding that there is a limit to the inaccessibility of the location in which a dynamo can be erected and properly cared for. . . . . , with the advent of the trained electrical engineer the members of the profession have reached the dignity where they may reasonably expect to be called into consultation with members of other professions on an equality, and where the interdependence does not mean amalgamation, but intelligent joint authorship." That is to say, the collaboration for which Professor Perrine makes his plea should be similar in its character to that which exists, for example, between the designers of the hull of a steamship and the designers of her engines and machinery. It is apparent that only in some such way can a thoroughly satisfactory result be reached, especially in the case of a large building or group of buildings. A competent architect, in the present state of knowledge, ought at least to be able to present a design in which the demands made upon the electrical engineer do not involve either impossibilities or unnecessary inconveniences.

Continuous vs. Alternating Arc Lights.

"A DIFFERENCE of opinion seems still to exist"—says Professor J. A. Fleming, in *Lightning*, the paper being reprinted in the *Electrical Review* (November 14)—"as to the relative advantages of the continuous and the alternating current arc as regards efficiency of illumination." As a contribution to the scanty stock of accurate knowledge now accessible on the subject, Professor Fleming gives a résumé of certain experiments made by him in order to ascertain the relative efficiency, measured in candle-power, of one and the same form of arc-lamp, when supplied successively with continuous and alternating currents. A special photometer was prepared for the purpose of measuring the intensity of the light at any degree of inclination to the horizon. In all the experiments, carbons of 13 millimeters were employed, and a wattmeter was connected directly to the carbons, so as to measure the energy actually expended in the arc itself. From the results of several hundred observations, a series of curves was constructed, showing, first, the relative distribution of light corresponding to a given "wattage" at different inclinations to the horizon, and second, the variations in mean spherical candle-power corresponding to the different watt-values of energy expended in the arc. The former showed, as might perhaps have been foreseen, that the greatest intensity of light is projected at an angle of about 48° from the ground line, while the second set of observations demonstrated that for a given expenditure of power in the arc, the mean spherical candle-power for the alternating current is less than that for the continuous in the ratio of about two to three. Apart from scientific measurements, it is the general experience of people, where alternating arcs are used, that although the lamps look bright enough to the eye, the illumination at the ground level is disappointing. The diagrams accompanying the paper show that with the alternating arc, the total illumination is divided equally about at the horizontal lane, half of it being projected upward at early the same angle, viz.: 48°. Hence if ie quantity of light directly available for ghting a floor-space be considered, the omparative efficiencies of the continuous nd alternating arcs are in the ratio of 6 o 2. The difference in practice need not e so great as this, because the light thrown pward may easily be reflected downward y means of a suitable reflector placed bove the lamp, although it is obvious that even the whole of this light could be sefully employed, the original ratio canot be increased. Furthermore, Professor 'leming ascertained from experiment, that rhile a certain continuous arc required .25 amperes and 45 volts to give a paricular candle-power, the alternating arc bsorbed 15 amperes and 37 volts in proucing an equal illumination, the apparent ratts being in the ratio of 372 to 555. Against these various disadvantages, says Professor Fleming, may be set off the reat convenience of having only one set f circuits. This has led to the employnent in some instances of alternate curents for direct-current lighting by means f rectifiers, the irregularities of which ave been found to assist the operation of he feeding-gear of the lamp.

Electricity on Shipboard.

IN the *Electrical-Engineer* (November 1) Lieut. S. Dana Greene's paper read beore the Society of Naval Architects and Marine Engineers on the present position nd future development of electrical apliances on shipboard, is given in abstract. The electrical plant has come to be conidered one of the vital necessities of the nodern war-ship, and is therefore always ocated in a special compartment by itself, s nearly in the central portion of the ship s possible, and below the protective deck. Vertical engines are to be preferred, and he dynamos should always be direct-coupled. Compound-wound slow-speed multipolar types of dynamos are best for marine purposes, and the full load efficiencv of each unit should not be less than 80 per cent.; in the best types in modern service it often runs as high as 83 to 85 per cent. The wiring of the vessel is the most difficult and expensive, as well as the most important part of the installation. The practice, formerly in favor in Europe, of utilizing the hull of the vessel as the return conductor has never been admitted in this country; its sole advantage consists in its cheapness, while on the other hand it has a number of serious faults. The lights should be grouped on a number of separate circuits which are united at the switchboard, those ordinarily used at the same time being arranged on the same circuit. Water-tight moldings and fittings are employed in all exposed places. The best rubber-covered wire is used, to which a good heavy coating of braiding is found to give all the mechanical protection necessary. The loss of potential in the wiring should never be permitted to exceed 5 per cent., and can usually be limited to 3 per cent. without excessive cost. The e. m. f. of all U. S. naval plants is 80 volts; a standard which has been adopted in order to permit the use of search-lights and incandescent lamps on the same dynamos, without interposing too much dead resistance in the search-light circuit. This reason does not apply to merchant vessels, in which the voltage may with advantage be made from 100 to 120. The most important future developments in marine applications are probably to be looked for in connection with the electric motor. The motor is well adapted to operate ammunition hoists, as well as the turrets of battle-ships and the heavy guns in the turrets. Ventilators, portable drills and pumps, deck hoists, and even steering-gear may be advantageously operated by electric motors. One most important suggestion of the author is that all the water-tight doors in a vessel might easily be opened and closed from a single point and with great celerity. If the ill-fated *Victoria* had been thus equipped, her compartments might all have been closed before the collision took place, and the ship saved. Among the most useful of recent electrical applications are electric search-lights and range-finders. The latter instrument will indicate quickly and with reasonable accuracy, the distance of any object at sea within the range of vision; often a matter of the greatest importance. It is likely to play an important part in future naval engagements, and may in some instances be the controlling factor in the determination of the result of the contest. Other minor applications of electricity pointed out or suggested by Lieut. Greene, constitute no inconsiderable part of the equipment of these modern fighting machines.

Conduit Electric Railways.

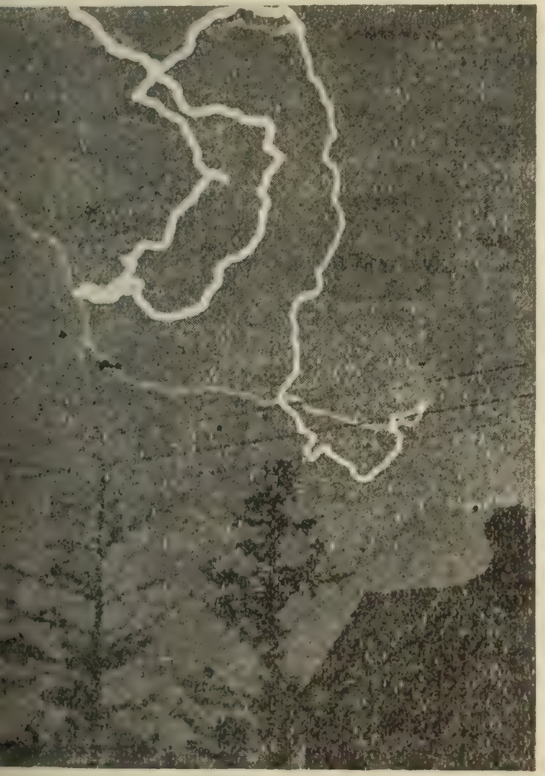
AT a recent meeting of the New York Electrical Society, Mr. Joseph Sachs read an exhaustive paper on the subject of electric railway conduit systems, which may be found in *Electricity.* The paper was fully illustrated, and describes in a clear and accurate manner the many principal plans which have thus far been proposed, and intelligently outlines the prospects for the future. Fortunately, the paper elicited a full and animated discussion, which was participated in by some of the leading authorities in the country. The general consensus of opinion among those best qualified to judge, appears to have been that there is no serious obstacle other than cost in the way of constructing a conduit system that will work. It must be admitted that the constructional difficulties are far greater than in the overhead system, but all these may be overcome if enough money is expended in the solution of the problem. This is particularly the case in respect to the electrical problems, but as Mr. Sachs points out, if the conduit be made large enough, and the voltage be reduced to a sufficiently low point—which involves of course, a material increase in the cost of copper for conductors—these difficulties are minimized, and may undoubtedly be overcome. There is scarcely a practicing electrical engineer in the country who, if asked whether it were possible to construct an operative electric railway upon the conduit plan, would not answer unhesitatingly, "Yes." Why then has not this method become more popular? Simply because it is in competition with a better method. There is but one single feature of the conduit that recommends it above the overhead trolley, and that is one that appeals to the esthetic side of our natures alone. In all other particulars the overhead system stands *facile princeps.* It cheaper to construct; it is simpler, both mechanically and electrically; it gives better service, and what is more important for its survival, it is a better dividend payer. What incentive, therefore is there to capital, to an investment of half-a-dozen or more times the money for something which even in its ideal perfection can only hope to equal that which we have already? Obviously, little or none.

Electric Power Transmission in California.

THE *Practical Engineeer* (November 2) contains a detailed account of an electric transmission plant at Bodie, Cal., by Mr. T. H. Leggett, which does not appear to have been published in the electrical journals of this country. The single-phase synchronous system is used, the distance being 12½ miles. The available head of water is 350 feet, which drives four 21-inch Pelton wheels rated at 60 horse-power each. These are on a common axis and are coupled direct to the armature shaft, the rate of revolution being from 860 to 870 per minute. A Doolittle differential governor is employed, and is found to do its work in the most satisfactory manner. The generator is a 12-pole 120 k. w. machine, and is insulated from the water-wheels by a hard-rubber disk enclosed in a rigid coupling. Its potential under full load is 3530 volts. The line is of No. 1 soft copper, supported on heavy poles placed 100 feet apart, and crosses a number of very steep ridges, one of which is the summit of the Sierra Nevada range. Deep-groove glass insulators on iron pins are used. A motor of 120 horse-power drives the 20-stamp mill of the Standard Consolidated Mining Company at Bodie. The mill and offices are lighted by 100-volt incandescent lamps, taking current from a 100-light converter at a reduction of 30.1, which is connected to the main line before reaching the motor-switchboard. The results of numerous tests are given, showing that about 70 per cent. of the water-power is obtained at the motor puley. The entire cost of the plant is stated o have been less than $45,000, while its operation, during a single month, effected a saving of about $2200. The daily saving over the use of steam is from $35 to $40, on a twelve-hour run.

How Lightning Strikes an Electric Line.

ONE of the most curious and remarkable photographs of a flash of lightning which has ever come under our notice was ecently secured by Mr. Richard Rea of Menominee, Mich., and forwarded to the *Electrical Review*. By courtesy of the *Review* we are enabled to reproduce the llustration, which appeared in its issue of November 14. A careful examination of he photograph will show that the characer of the flash was spiral, and that its diection was away from the camera, the arge irregular loop in the upper part of he picture being quite near the spectator. From this loop the discharge passed downward and in front of the three elecric wires, being deflected slightly from its course by the repulsive effect of the current flowing into the upper wire, and again deflected, still more sharply, by the atractive effect of the current in the lower wire, of opposite polarity (the wires are stated to be those of a three-wire low-tension system). It then passed up in front of and over the neutral wire, taking a turn completely round it, and then going behind the two upper wires away into the distance, with greatly diminished brilliancy and intensity, showing that it had parted with a considerable volume of its original energy, which was carried away by the neutral wire. This photograph is a most valuable contribution to the mass of facts respecting the action of lightning which has been in course of accumulation within the past few years. It will be interesting to hear what the experts in this line are able to learn from it.



Determining the Efficiency of Electric Motors.

ONE of the most intelligently and clearly written explanations of the how, why and wherefore of testing an electric motor for determining its efficiency which we have ever met with, is given by James F. Hobart in the *Safety Valve* (November). Mr. Hobart's article presupposes a knowledge of elementary mathematics, but to one who has mastered these, the instructions and explanations will be found quite sufficient for a complete understanding of the subject, although the meaning of the author is unfortunately obscured by the repeated occurrence of the word "tongue," which the intelligent compositor has thought fit to substitute for "torque." Nor would it have done any harm if the author had given, in a foot-note or otherwise, some explanation of the meaning of this expression which, although well enough known in former days to theoretical machinists, did not make its appearance in the work-shop until the advent of the electric motor. With reference to the use of technical terms it may be appropriately added that new ones are constantly appearing, and new uses are found for those already in use; and it renders any exposition more acceptable if the significations of such terms as have not yet found their way into dictionaries are briefly and clearly defined in the significations employed. Even if some terms are unnecessarily defined no harm would result.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Lighting.

*26762. The Electricity Works at Bolton. Ill. (E E L-Nov. 2.) 6000 w.

26851. The Perrine Scale for Wiring Calculations. Ill. (E E N Y-Nov. 14.) 300 w.

26889. Profit in Small Lighting Plants. J. C. Pratt (S M-Nov. 15.) 900 w.

*26939. The Electricity Works at Southport. Ill. (E E L-Nov. 9.) 3000 w.

27006. The Windmill Electric Lighting Plant at Marblehead Neck, Mass. Ill. (E E N Y-Nov. 21.) 1000 w.

*27096. Hampstead Central Station. Ill. (E E L-Nov. 16.) 1400 w.

*27126. Distribution of Light from Arc Lamps. Ill. Rankin Kennedy (E R L-Nov. 16.) 500 w.

*27132. An Outstanding Problem. Editorial. (El-Nov. 16.) 1800 w.

27163. Electric Lighting by Windmill Power. Bell Crank (A M-Nov. 29.) 1400 w.

27209. High Candle Power Gas Rivalry. H. W. Frund (E W-Dec. 1.) 1000 w.

*27293. Lighting Installations. H. A. Henderson, with Discussion (El-Nov. 23.) 2600 w.

27429. Distribution of Light, Heat and Power at the Kalamazoo Insane Asylum. Ill. (W E-Dec. 8.) 3500 w.

27436. Suggestions for Buffalo's Electrical Carnival. Ill. Frank C. Perkins (E W-Dec. 8.) 900 w.

Power.

*26662. Operating Machine Tools by Electricity. Ill. George Richmond. (E Mag-Jan.) 3000 w.

*26736. An Electric Power Transmission Installation.—In the Mining District of Bodie, in California (P Eng-Nov. 2.) 1500 w.

*26756. Progress of the Electric Locomotive (Inv-Nov. 3.) 1900 w.

*26882. Selling Power for Outdoor and Farming Purposes. Ill. (S R R-Nov.) 800 w.

†26922. Some Facts About Polyphase Motors. Louis Bell. (T A I E E-Nov.) 4000 w.

†26924. Experiments on Two Phase Motors. Ill. Dr. Louis Duncan, S. H. Brown, W. P. Anderson and S. Q. Hayes, with Discussion (T A I E E-Nov.) 4800 w.

26935. Motors: Their Efficiency and How Determined. James F. Hobart (S V-Nov. 15.) 2700 w.

*26978. A Few Remarks About Accumulators (E R L-Nov. 9.) 1100 w.

*27122. Progress in Electrical Transmission. The Latest Improved Plant, West Pullman, Ill. Ill. (M-Nov. 15.) 2000 w.

27192. The Kearney, Neb., Water Power. Ill. (E E N Y-Nov. 28.) 800 w.

27193. Woonsocket Electric Company's New Water Power Plant. Ill. (S E-Nov.) 700 w.

27196. Electric Elevator Performance (S E-Nov.) 1000 w.

27201. Accidents in Large Power Plants. Ill. (W E-Dec. 1.) 800 w.

*27291. Notes on Rotary Field Motors. Silvanus P. Thompson (El-Nov. 23.) 2500 w.

*27335. Non-Synchronous Alternating-Current Motor for High Pressure. Ill. (E E L-Nov. 23.) 500 w.

27437. Wire Losses, Over Compounding of Dynamos, and Regulation of P. D. in Multiple Arc Circuits. E. P. Roberts (E W-Dec. 8.) 1600 w.

Telephony and Telegraphy.

26727. The Minimum Current Audible in a Telephone. Arthur Vaughn Abbott (E E-Nov.) 700 w.

26791. The Telephone in War (E R N Y-Nov. 14.) 500 w.

26956. A Resurrected Chapter in the History of the Invention of the Telegraph. G. Wilfred Pearce (E N Y-Nov. 21.) 700 w.

26962. Telephoning Election Returns (E R N Y-Nov. 21.) 1500 w.

27191. The Early Morning Test in Telephone Offices. Ill. J. W. Manson (E E N Y-Nov. 28.) 700 w.

27246. The Telephone Door. Angus S. Hibbard (E E-Dec.) 2200 w.

27278. A Novel Use for Telephones.—To Bring Warning of Coming Earthquakes (B J C-Dec. 1.) 500 w.

*27348. The National Telephone Company's New Exchange. Ill. (E R L-Nov. 23.) 1800 w.

27382. Telegraphing Without Wires. Ill. Erich Rathenau (E R N Y-Dec. 5.) 1200 w.

†27407. Proposals for the Canadian Pacific Cable (I R W-Dec. 10.) 1000 w.

Miscellany.

26726. The Interdependence of the Architect and the Electrical Engineer. Frederic A. C. Perrine (E E-Nov.) 800 w.

26728. Electricity: Its Social and Political Influence. George Iles (E E-Nov.) 800 w.

*26749. Note on the Measurement of Insulation and Other Resistances. Ill. Albert Campbell (El-Nov. 2.) 500 w.

*26778. Electrical (So-Called) Body Appliances. H. Newman Lawrence (E R L-Nov. 2.) 2700 w.

26792. Continuous and Alternate Current Arcs. Ill. J. A. Fleming (E R N Y-Nov. 14.) 2600 w.

26797. Speaking Along a Ray of Light. Ill. Nelson W. Perry (E N Y-Nov. 14.) 2300 w.

*26814. Alternators for Central Stations (E P-Nov.) 1500 w.

26863. Electrical Fires. Ill. (W E–Nov. 17.) oo w.

*26880. Absurdity of the Recent Rules dopted by the Underwriters International lectric Association, Covering the Use of 500-olt Fuses. W. E. Harrington (S R R–Nov.) oo.

26888. Dynamo Currents for Fire Alarm stem. B. S. Flander (F W–Nov. 17.) oo w.

†26923. On the Law of Hysteresis, and the heory of Ferric Inductances. Charles Pro-us Steinmetz, with Discussion (T A I E E–ov.) 4800 w.

*26942, The Electric Conductivity of Pure ater. J. W. Rodger (N–Nov. 8.) 1400 w.

26961. The Treatment of Sufferers by Acci-ntal Electric Shock (E R N Y–Nov 21.) oo w.

*26988. On the Refraction and Dispersion of ays of Electric Force. A. Garbasso and E. schkinass (El–Nov. 9.) 1600 w.

27008. Electricity on Shipboard. S. Dana reene (E E N Y–Nov. 21.) 1800 w.

27017. Fusion and Volatilization Produced by eans of the Heat of the Electric Arc. Henri oissan (Sc A S–Nov. 24.) 2000 w.

27136. Killing by Electricity (E R N Y–Nov. .) 1300 w.

27181. Some of the Less Understood Elec-ical Phenomena—The Alternating Current and s Manifestations—Electro-Magnetic Induction. elson W. Perry (E N Y–Nov. 28.) 2200 w.

27200. Electrical Production of Ozone for the reatment of Disease. Ill. (W E–Dec. 1.) oo w.

27206. The Definition of Reactance. C. P. einmetz and Frederick Bedell (E W–Dec. 1.) oo w.

27247. Concerning Electrical Fads. Louis ell (E E–Dec.) 1000 w.

27256. "What Is Electricity?" What Elec-icity Is. John M. Bachelor (E A–Dec. 1.) o w.

*27271. The Electrical Accident in Cannon reet (Eng L–Nov. 23.) 2400 w.

*27292. Researches on the Occlusion of Elec-olytic Gases by Porous Bodies, Especially by etals of the Platinum Family: Its Application Gas Batteries and Pressure Electric Accumu-tors. L. Cailletet and E. Collardeau (El–Nov. .) 1500 w.

*27334. On the Effect of Magnetization on the Dimensions of Wires and Rings of nnealed Iron. Shelford Bidwell (E E L–Nov. .) 1700 w.

*27346. Theory and Practice in Electrical ngineering. Rankin Kennedy (E R L–Nov. .) 1600 w.

*27347. Experiments in the Utilization of emical Energy for the Production of Elec-city. Ill. (E R L–Nov. 23.) 1000 w.

27377. An Improved Form of Interrupter Large Induction Coils. Ill. F. L. O. dsworth (A J S–Dec) 1600 w.

27396. Light Without Heat. Nelson W. Perry (E N Y–Dec. 5.) 1800 w.

27410. Armature-Disc Cutting. Oberlin Smith (E E N Y–Dec. 5.) 2200 w.

27411. Some Aspects of Electrical Education. W. M. Stine (E E N Y–Dec. 5.) 3300 w.

27435. Electrical Differences of Potential—An Analogy. John Waddell (E W–Dec. 8.) 1350 w.

27438. Transformer Testing. Eustace Oxley (E W–Dec. 8.) 1000 w.

Serials.

22059. Practical Notes on Dynamo Calculations. Ill. Alfred E. Wiener (E W–Began May 19—20 parts to date—15 cts. each).

22131. The Incandescence Lamp. Ill. A. Bainville (E R L–Began May 11—7 parts to date—30 cts. each).

23866. Electrodynamic Machinery. Ill. E. J. Houston and A. E. Kennelly (E W–Began July 21—18 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A–Began Aug. 25—14 parts to date—15 cts. each).

25095. Postal Telegraphs. Ill. James Bell (E L–Began Sept. 7—12 parts to date—30 cts. each).

25105. Standard Units for Electrical Measurement. Ill. (E R L–Began Sept. 7—5 parts to date—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y–Began Sept. 19—12 parts to date—15 cts. each).

25482. The Chemical Theory of Accumulators. E. J. Wade (El–Began Sept. 21—6 parts to date—30 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Ill. Howard Pentland and Alfred H. Gibbings (E L–Began Oct. 5—8 parts to date—30 cts. each).

26235. The Diseases of Dynamos (E R L–Began Oct. 19—Ended Nov. 2—3 parts—30 cts. each).

26377. Resonance Analysis of Alternate Currents. M. I. Pupin (A J S–Began Nov.—2 part to date—45 cts. each).

26518. The Surplus and Deficit Theory of Electricity. W. Perren Maycock (E E L–Began Oct. 26—Ended Nov. 23—4 parts—30 cts. each).

26592. Electrical Power Transmission. Ill. Louis Bell (E W–Began Nov. 10—3 parts to date—15 cts. each).

26945. Electricity on Board Ship and Its Application as Motive Power for Auxiliary Machinery. Alfred H. Gibbings (E L–Began Nov. 9—3 parts to date—30 cts. each).

26986. Principles of Transformer Design. Ill. Alfred Still (El—Began Nov. 9—Ended Nov. 23—3 parts—30 cts. each.)

27371. The Electric Light. Henry Stooke (I C B–Began Nov. 23—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY

May a Man Conduct his Business as He Please?

WHAT may a man do with his own? It is a popular idea, and a popular expression also, that "a man may do what he pleases with his own"; yet there are certain legal limitations which a man attempting to apply such a rule in conduct will soon be made to realize, and certain moral obligations to society and to humanity in its broadest sense,—obligations which cannot practically be made the subject of legal enactment,—yet whose violation will entail the loss of social respect and the disapproval of just and humane men the world over.

A man's fist is his own, yet he may not from anger or malice use it to smite a fellow citizen, without exposing himself to a penalty for the act. Except in self-defense he may not assault his neighbor with violence. His house is his own, yet he may not at will use it for a brothel or a gambling house. No matter how sound may be the title to his property, if certain maladies appear in his dwelling both he and his family may be shut up in his own house and kept there secluded from personal communication with neighbors until the house has been purged of contagion; or they may be removed to a pest house when it is necessary to prevent the spread of a dangerous disease. These are familiar examples of limitations which may restrain men from doing absolutely what they will with their own. Many other limitations to rights of personal ownership exist in the statutes of all civilized countries. The right of absolute control under all circumstances does not legally exist anywhere except among savages; and even with savages some rudimentary limitations to rights of ownership may be found.

This line of argument has been followed out with severe logic by Hon. Carroll D. Wright in *The Forum* for December, and the argument points directly toward modern business methods. He evidently thinks the recognition of ethical principles on the part of employers of labor will ultimately be forced by public opinion, though confessing, that, from an economic point of view, there is no visible way to bring about such recognition. At the same time if ethical principles are to exert an influence on employers they must simultaneously react upon the employed. The subject is so thoroughly elaborated that it is not easy, in a review, to present a fair view of it, but it will be possible to reflect the more important points of the argument.

"Shall a man conduct his own business in his own way? Shall the savings of labor be considered a reserve, from which labor must draw, in order to enable it to subsist during periods of depression or of adversity, while the reserve of capital is kept practically intact under like circumstances, or, if drawn upon at all, in less measure than labor draws upon its savings?"

"The great employer of to day, when asked to make some concessions to labor or to arbitrate differences which have arisen between him and his employés declares that in order to win success he must have complete control of his own affairs; and he asks, 'Shall I not conduct my own business in my own way?' Under some circumstances the employé asks, 'Have you the right to conduct your business in your own way?' Society has long since answered these questions in some important particulars. It says to the property owner, the manufacturer: 'You must not so conduct your business as to injure the property of your neighbor, nor must you conduct your business in such a way as to injure the health of your neighbor. No property owner can do anything that will interfere with the rights and privileges of his neighbor, whether these rights and privileges come under the head of right to freedom from injury to property, or the privilege of living without damage to health.' These principles are so old, and so well defined by precedent and by stat-

hat the answer is complete and em-
c in so far as the two features named ;
o question is made as to the sound-
either in ethics or economics, of the
ion which society has taken in the
ises. . . . But the question which is
ore reaching, and which will inevit-
be answered by society, relates to con-
ns of men rather than to their mate-
surroundings ; and this question :
ll a man or a corporation who does
or is not able to, conduct his or its
rs so as to avoid public disturbance,
ruction of trade, loss of wages, or the
ring of the standard of living, be free
the interference of society ?' Will
ommunities say to the employer : 'If
cannot so conduct your business, or
ufacture, or railroad that public busi-
be not disturbed or the standard of
nterfered with, we shall take some part
e management, or insist upon some
stment by which society shall be free
disturbance ?' The broad answer will
e in due time,—in fact, it has come,—
by revolutionary methods, but by the
esses of reason, the application of
ce, and the rule of right."

is argued that consent to arbitration
ifferences between labor and capital is
cit reply in the affirmative to the ques-
s propounded, as is also the existence
tate Boards of Arbitration, under leg-
ive enactment the constitutionality of
ch cannot be denied. The Interstate
nmerce Law is a "clearly defined in-
ce of the necessity of government in-
erence to prevent disturbance of trade.
can interfere to prevent the disturb-
of trade, can it not interfere to pre-
the disturbance of society ? Cannot
State say to both labor and capital,
u must so conduct your affairs as to
e people at peace'? It must be admitted
nce that, in so far as the individual is
erned, the extension of this answer to
scope which it will take in the future
neconomic. It is not good political
omy, perhaps, but is it not good
s?"

e position is taken and ably main-
d that the savings of labor is one of
reserves as essential to the integrity
of the business of a community as the reserves of capital," or "the undivided profits of business held by capital for legitimate purposes. "The trouble comes when, through depression, through competition, or other circumstances, wages are reduced ; and, in so much as they are reduced, the possibility of keeping labor's reserve intact is lessened. If the necessity extend or continue, the possibility of keeping the reserve intact is not only lessened, but completely destroyed ; and, in order to keep in condition to earn even enough wages to come up to the life-line, the reserves are drawn upon and in many cases entirely exhausted, in order that the processes of production may go on. Capital, in the meantime draws upon its reserves to sustain its productive processes, while it may and often does reduce the usual dividends ; and sometimes its dividends may be wiped out completely, just as the surplus earnings of labor may be wiped out completely. But recently we have seen that labor has not only been obliged, under the depressed condition of business, to accept most serious reductions in wages, but to draw heavily upon its reserve ; while capital not only preserved its reserve intact, but did not suffer materially in its dividends, although it did meet current losses in its production."

Is this state of things fair to labor ? If not, can legislation change the condition, or must the change come through the powerful influence of public opinion ? A man may do anything with his property that statute law, as administered in law courts, permits, yet if he does not set some other than legal bounds upon conduct, he will incur social penalties that to many men are as hard, perhaps harder to bear than those imposed for legal offenses. To lose self-respect, the respect of neighbors, to feel that one's name is spoken only with contempt, to become ostracized from the esteem of honest, honorable men, to realize that one has by his selfish disregard of public opinion alienated himself from the esteem of worthy people, to be shunned by those whose society is desirable, to be black-balled in clubs, and cut in public places ; these are penalties of an unwritten code whose restraining power upon conduct is, except upon the lower types of moral development, more potent than that of statute law. The force of this unwritten law is felt everywhere above the stratum of crime in society, and it is an axiom that "there is honor even among thieves."

It is wholly impracticable to regulate by statute all the actions of men. It is desirable that people should treat each other with politeness, yet it would be foolish to attempt to make people polite by legislative enactment. Statute law imposes penalties for lying, only in two cases, lying under oath upon matters material to a legal issue, and lying about any of the things specified in statutes relating to slander or libel. In all other matters a man may lie without incurring a legal penalty; yet over the wilful, habitual liar hangs the penalty of the contempt which all honorable men accord to habitual liars. This fact, that there are and must always be two kinds of law by which men are controlled in their dealings with each other, statute law and moral law, which latter should be identical with the law of honor, seems to have been lost sight of by some writers in dealing with the sociological questions now uppermost in public interest.

The cry is for more legislation, more statute law, and for the most part the proposed legislation is of a nature which the history of mankind has over and again demonstrated to be impracticable. As a matter of fact there now exist statutes intended to control certain matters that would be much better governed by the law of public opinion in the absence of statutory provisions regarding them. Good government suffers more through excessive legislation than for any lack of legislation.

The law of human kindness, too much forgotten in the pull and push of modern trade, is the only law that can regulate the intercourse between employers and employed. This, though not expressly stated in Mr. Wakeman's paper, printed in this Magazine for October, is implied in all he says with reference to the treatment which employers are morally bound to accord to workmen in shops and factories. Judge Trumbull recognizes this when in his speech delivered recently before an audience of populists in Chicago he says:

"I would call upon the millionaires for heaven's sake to pause in their greed for more millions, and unite in the passage of laws which, by securing equal opportunities to all, shall contribute to the happiness of all."

But even were it possible to pass laws that would equalize opportunity, no legislation can equalize the ability of men to acquire, and supreme selfishness combined with business foresight would still lead in the race for wealth. If supreme selfishness, by an improved standard of morality and honor, could be made as disreputable as cheating and lying now are, there would be fewer millionaires.

Mr. Ashley, in his paper reviewed in November, evidently sees the need for improvement in business morality, when he speaks of fairness as an element of success in his scheme of profit sharing. Nothing could be truer; but, if fairness in dealing were a ruling motive on both sides at the present time, all difficulties between employers and the employed could be easily and amicably settled. Fairness in dealing implies a plane of morality on which supreme selfishness cannot stand. If all employers could attain to this plane of morality, each would be solicitous that employés should get their full and just share of the products of their labor. If all employés stood on this plane, every man of them would constantly study how to render the full equivalent of service for wages received. As it is now, the majority of both employers and employed in dealing with each other are governed by supreme selfishness, each seeking to give as little as possible for what he gets regardless of the golden rule. On this higher plane, a combination of men after having amassed many millions of dollars through the assistance of employés, would not cut wages to the starvation point, when the maintenance of wages through a streak o hard times seemed likely to take away an inconsiderable fraction of those million and distribute it among those who in prosperous times had helped to create them.

Until both employers and wage earner

have been elevated to this higher plane of morality, all laws intended to promote a more uniform distribution of wealth will fail. The principles of equity must become a general rule of action, else all laws of this kind will be evaded, and if this rule prevailed there would be no need of the laws. There are laws against usury; yet, when any man wishes to pay more than the legal rate for the use of money, he can always find a lender who will advance the money wanted, on sufficient collateral security, and do it in a way that the law cannot reach. Our usury laws are good examples of the impracticability of all laws whose effective execution is not backed by a positive and general current of public opinion.

The Chicago Strike.

When some future historian shall write a history of the world, recording the events of the last decade of the nineteenth century, he will find in the annals of the year 1894 abundant material for a most interesting chapter. The great commercial depression, the war between Japan and China, and its results, the onward march of scientific discovery, the great engineering works in progress, the futile struggle for efficient tariff reform in the congress of the United States, the unrest of the masses, culminating in the great strike at Chicago, are events numerous and important enough to inspire a masterpiece of historical description.

In writing about the strike our supposed historian will find no better material than the official report of the United States Strike Commission appointed by the President, July 26, 1894. This commission, consisting of Carroll D. Wright, U. S. commissioner of labor, John D. Kernan of New York, and Nicholas E. Worthington of Illinois, have submitted a report to the President which fills a pamphlet of 52 pages. *The Boston Journal of Commerce* (Nov. 17) contains a comprehensive abstract of the document.

In a session of thirteen days, 107 witnesses were examined. A copy of the testimony thus obtained was transmitted with the report, and it substantiates all the statements made in the report as submitted. Briefly then, the history of the strike will be based on the following facts.

The employés of the Pullman car company very generally joined the American railway union in March and April, 1894, and the nineteen local unions thus formed declared a strike at Pullman, hoping thereby to force the Pullman car company to accede to certain demands made by the workmen, the chief of which was an increase of wages, that on account of the effects of commercial depression upon the business of the company had been severely cut.

The General Manager's Association is a voluntary unincorporated association founded in 1886, having as members the twenty-four railroads centering in Chicago, together operating 40,933 miles of road, having a total capitalization of $2,108,552,617, and giving employment to 221,097 men. The object of the organization is, ostensibly, "the consideration of problems of management arising from the operation of railroads terminating or centering at Chicago." Upon this organization the significant comment is made that "there are no limitations as to consideration of problems or of funds (raised by assessment divided equally among the members) except the will of the managers and the resources of the railroad corporations."

The Pullman Car Company was organized in 1867, with a capital of $1,000,000. Its present paid up capital is $36,000,000. The profits of the business have permitted the payment of 2 per cent. quarterly dividends and the accumulation of a surplus of $25,000,000, undivided profits. For the year ending July 1, 1894, the dividends considerably exceeded one half the wages paid for that fiscal year. The business of the company is as follows:

"(1) The operation of its cars upon about 126,000 miles of railroad, being about three-fourths of the railway mileage of the country, under contracts similar to that in evidence. (2) The manufacture and repair of such cars. (3) The manufacture of cars of all kinds for the general market. (4) The care and management, as owner and landlord of the town of Pullman."

Not to go into the details of the history of the erection of the town of Pullman by the Pullman Car Company, some of its peculiar features may be noted. It is a town where no workman employed by the company can acquire ownership of real estate. The rentals collected from workmen are about 25 per cent. higher than for the same grade of dwellings in Chicago. All library privileges, etc., if used, are paid for by the user. If workmen are injured in the service of the company they must be attended by a surgeon provided by the company, whose duty is, also, "to secure from the injured party a written statement as to the causes of injury, and it is his custom to urge the acceptance of any offered settlement." This system is characterized as "admirably conceived from a business standpoint to secure speedy settlement of claims for damages upon terms offered by the company, and to protect it from litigation and its results." In short, it appears from the report, that the scheme of the city of Pullman, was only intended to subserve the interests of the Pullman car company, and to aid in the control of the skilled labor that could be attracted to the town.

The American Railway Union is an association of about 150,000 railroad employés, organized June 20, 1893, including railway employés born of white parents. One of its avowed purposes was to prepare railway employés to meet with united resistance any unjust restriction or regulation which the organization of general managers might impose; and although the American Federation of Labor, with a membership of 500,000, at one time seemed willing to support the strike, the main contest was between the General Managers' Association and the American railway Union. The strike utterly failed to accomplish its purpose. The condition of the striking employés of the Pullman Car Company was rendered worse by it, while the commerce of the country was seriously deranged. The cost of the strike affected by it is summarized as follows: Hire of United States deputy marshals, and other incidental expenses at least $685,308. Loss of wages by workmen at Pullman, at least $350,000. Loss of earnings by railway employés, $1,389,143. Many of the latter are still adrift and losing wages. Other widely distributed losses cannot be more than guessed at. There were shot and fatally wounded, 12; number arrested by the police, 575; number arrested and indicted under United States statutes, 71; number arrested but not indicted, 119.

"These great losses and many crimes; the vast numbers, strength and resources of the labor that contended under the leadership of the American Railway Union upon the one side of the Pullman palace Car Company and the General Managers' Association upon the other; the attitude of labor toward capital, disclosed in its readiness to strike sympathetically; the determination of capital to crush the strike rather than to accept any peaceable solution through conciliation, arbitration, or otherwise; the certainty with which vast strikes let loose the disreputable to burn, plunder, and even murder; the conversion of industrious and law-abiding men into idlers, lawbreakers, or associates of criminals; the want brought to many innocent families; the transformation of railroad yards, tracks and stations, as well as the busy marts of trade, into armed camps; the possibilities of future strikes on more extended lines of union against even greater combinations of capital—are all factors bearing upon the present industrial situation which need to be thoroughly understood by the people and to be wisely and prudently treated by the government."

As to causes of the strike they are found in the existence of the organization named, in the conduct of the Pullman Car Company toward its employés, and in the unwise action of the American Railway Union in admitting the workmen of the Pullman car shops into the organization. The leaders of the association at first opposed the strike, but found themselves, under the principles of the union, obliged to sustain it when once begun by Pullman workmen whom they could no longer restrain from their purpose.

The Pullman Car Company does not occupy an enviable position in this report. The deposits in the Pullman loan and savings bank (substantially those of the workmen, half of whose accounts were under $100, and five-sixths under $500) diminished nearly one-half from July 1, 1893, to August, 1894. "These figures show how seriously the cutting down of wages ate into savings."

"As the result of the Pullman system and its growth, when the depression of 1893 came, morally calling for mutual concessions as to wages, rents, etc., we find on the one side a very wealthy and unyielding corporation, and upon the other a multitude of employés of comparatively excellent character and skill, but without local attachments or any interested responsibility in the town, its business, tenements, or surroundings. The conditions created at Pullman enable the management at all times to assert with great vigor its assumed right to fix wages and rents absolutely, and to repress that sort of independence which leads to labor organizations and their attempts at mediation, arbitration, strikes, etc."

The report regards the Pullman car company as "behind the age" in its hostility "to the idea of conferring with organized labor in the settlement of differences arising between it and its employés. The company does not recognize that labor organizations have any place or necessity in Pullman, where the company fixes wages and rents, and refuses to treat with labor organizations. The laborer can work or quit on the terms offered ; that is the limit of his rights. To join a labor organization in order to secure the protection of union against wrongs, real or imaginary, is overstepping the limit and arouses hostility. This position secures all the advantages of the concentration of capital, ability, power, and control for the company in its labor dealings, and deprives the employés of any such advantage or protection as a labor union might afford.

"The strike was of the kind known as sympathetic." The railway employés engaged in it had no grievance of their own, but sacrificed themselves to the support of the principle of "solidarity of labor." The boycott of the Pullman cars would have been an "incongruous step for the remedy of complaints of railway] employés." It risked the integrity of the association in an unwise and unnecessary way. It provoked the antagonism of all the railway lines, placing the latter in a position where they must either violate contracts and incur penalties, or oppose the misdirected effort to aid the workmen at Pullman in their conflict with the company.

"To preserve the integrity of associations designed to unite and organize labor on such a broad basis as that of the American railway union but two courses seem open : (1) To take a position against all strikes, except as a last resort for unbearable grievances, and to seek the more rational methods of conciliation and arbitration. To this object the power of public opinion would lend aid to an extent not now appreciated. (2) Conservative leadership, legal status, and the education of members in governmental matters, with the principle in view that in this country nothing can accomplish permanent protection and final redress of wrongs of labor as an entirety except conservative progress, lawful conduct, and wise laws enacted and sustained by the public opinion of its rulers—the people."

As to the General Managers' Association, this strike first exhibited its strength in opposing an organized attempt to obstruct traffic, and its energy and ability were conspicuous during the struggle. Prior to this event its attention had been almost wholly directed to "questions concerning transportation centering at Chicago in which the roads had a common interest. It thus determined the policy and practically fixed the relations of all the roads toward the public, as to switching, car service, loading and unloading cars, weights of live stock, rates, etc., and sustained each road in maintaining the position of the association as to these matters." No question has been made of the usefulness of the association both to the roads themselves and to the public. That it was forced into a conflict with its employés in the Chicago strike is not denied. Its vigor in meeting the attempt to coerce the roads into abandoning the use of Pullman cars is acknowledged. The justice of its course must be conceded. At the same time it is seen that peaceful settlement of labor questions is not to be expected when great corporations like the Pullman car company maintain the attitude toward workmen displayed in the evidence on which this report is based. Such an attitude is so arbitary and exasperating as to make strikes inevitable, if not justifiable. It is not in human nature to submit patiently under such provocation, and it is foolish to expect.

INDEX TO LEADING ARTICLES

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

25590. The Liability of Labor Unions for Damages—The Lucke Case. R. W. Raymond (E M J–Sept. 29.) 500 w.

25591. Bimetallism vs. Silver Monometallism (E M J–Sept. 29.) 1500 w.

25618. Governor McKinley Compares the New and the Old Tariff Laws (B I S–Oct. 23.) 1500 w.

†25963. The Work of the Beer Money. John Rae (C R–Oct.) 12000 w.

*26656. Silver Coinage Historically Considered.—A Masterful Review of Facts and Principles. Henry Downing MacLeod (E Mag–Jan.) 3000 w.

*26709. A Ship-Yard Foreman on Trades Unions and Labor Troubles (Eng L–Nov. 2.) 1200 w.

*26720. Depression in 1847 and 1894 Compared (B M–Nov.) 3300 w.

*26721. The Volume of Currency and Prices (B M–Nov.) 2300 w.

26764. The Wages of Employés. Editorial (R A–Nov. 9.) 1100 w.

26782. Cornering Gold. Editorial (M I T–Nov. 8.) 600 w.

26799. New York City's Magnificent Commerce (Sea–Nov. 15.) 3000 w.

26800. A Coöperative Contract System. John Richards (A M–Nov. 15.) 4200 w.

†26829. The Monometalist Creed. Henry Dunning MacLeod (N C–Nov.) 5000 w.

*26840. Building Land in Scotland (A L–Nov. 2.) 1800 w.

26849. Convicts on the Public Roads. Professor Holmes Gives the Workings of this System in North Carolina (M R–Nov. 16.) 3000 w.

26859. The Chicago Strike.—Report of the United States Strike Commission Appointed by the President July 26, 1894 (B J C–Nov. 17.) 5800 w.

26873. The Brotherhood Suit Against the Reading, with Editorial (R G–Nov. 16.) 2800 w.

26913. An Open Letter.—To the Hon. Carroll D. Wright, the Hon. John D. Kernan and the Hon. Nicholas E. Worthington (R A–Nov. 16.) 2200 w.

26934. Prevention of Railway Strikes. James Peabody (R R–Nov. 17.) 2700 w.

†26950. Pseudo Individualism; or the Present Slavery. Arthur Withy (W R–Nov.) 6000 w.

27058. The Chicago Strike Report. R. W. R. (E M J–Nov. 24.) 1500 w.

*27103. Institutions and Economics. Editorial (I & I–Nov. 16.) 1600 w.

*27117. The Economic Development of Canada. (Abstract.) Charles Tupper (I & S–Nov. 17.) 2000 w.

*27145. Pullman and Paternalism. Charles H. Eaton (A J P–Dec.) 3300 w.

*27146. The Burden of Indiscriminate Immigration. Julia H. Twells (A J P–Dec.) 3000 w.

*27147. A Practical Example in Civics. Thomas W. Haskins (A J P–Dec.) 2500 w.

*27148. Dangers of Paternalism. G. F. Milton (A J P-Dec.) 3000 w.

*27149. A Labor Trust. E. M. Burchard (A J P–Dec.) 2400 w.

*27150. A Proposed Remedy for the Railroad Troubles. George Gary (A J P–Dec.) 1200 w.

†27216. Our Experiments in Financial Legislation. James H. Eckels (N A R–Dec.) 2800 w.

*27249 May a Man Conduct His Business as He Please? Carroll D. Wright (F–Dec.) 3000 w.

*27250. Stock-Sharing as a Preventive of Labor Troubles. Louis R. Ehrich (F–Dec.) 2200 w.

*27251. Is the West Discontented? A Local Study of Facts. J. H. Canfield (F–Dec.) 5000 w.

27299. A Dutch Coöperative Town (A A–Dec. 1.) 1300 w.

*27321. Coöperative Engineering. Editorial (E–Nov. 23.) 2900 w.

*27391. The Cause of Panics. T. W. Graham (Mill–Nov.) 1800 w.

†27412. The Nature of Political Authority. Editorial (P S M–Dec.) 1200 w.

27425. Decision Against Brotherhood Employees on the Reading (R G–Dec. 7.) 3200 w.

27445. John Burns' Visit. Editorial (A & B–Dec. 8.) 1000 w.

MARINE ENGINEERING

The Training of Marine Engineers.

EVERYWHERE that civilization has advanced to the adoption of machinery as a substitute for manual labor, the subject of education holds a prominent place as a factor in industrial progress. Even in Japan, the latest and most wonderful example of national development, education is regarded as a *sine qua non* by its intelligent and able government. By educating officers and engineers, her smaller area and comparatively smaller population has been made more than a match for the Chinese hordes, and by her recent military exploits she has won a most influential and enviable position among oriental powers.

The Institute of Marine Engineers (England), having addressed a letter to the Board of Trade "advocating certain changes from present rules in the training of marine engineers," the board referred the subject back to that body and to other societies for advice. Thereupon the Institute of Marine Engineering adopted the following resolution :

"That in the opinion of this meeting, it is highly necessary to amend the present regulations as to second-class certificates for engineers with regard to service in the workshop, where the minimum service should be five years; and that the attention of the Board of Trade should be called to the desirability of creating a third-grade certificate, which should be granted to those who have served at least five years in an engineering work, and one year at sea, and passed the prescribed examination."

The following argument also accompanied the resolution : "Greater and increasing responsibilities rest on the engineers of to-day as compared with those of the past. Foreign competition is greater and increasing, and it rests largely with the most intelligent use of material in the engine department to gain the advantage in the competition. There is less hand and more machine tool labor in our workshops now than formerly, and, therefore, the more reason for an extended apprenticeship. In our large steamers there are many young engineers who sail for years in a capacity junior to fourth engineer, and who have no opportunity for passing the examination for second engineer, but who might have granted them an opportunity of obtaining a third-grade certificate as a means of encouragement."

This resolution and the remarks accompanying it, as presented to the Board of Trade, are printed and made the source of editorial comment in *Engineering* (London, Nov. 16) which remarks that "the questions at issue in regard to a longer period of workshop experience for marine engineers are so various that it is difficult to know from what point to approach the subject.

"Undoubtedly it is desirable that our sea-going engineers should have a thorough practical knowledge of the engines under their charge ; but that a theoretical or scientific knowledge of marine engineering is necessary for sea service, *i. e.*, service afloat, is a matter which is evidently considered by some to admit of discussion. No doubt in order to be a good marine engine designer, it is highly desirable that a man should have had experience of the working of marine engines in actual use. That is the other side of the question, but engineers afloat are not required to design engines."

If the standard of qualification be raised too high it is thought the supply may easily become too small to meet the demand for qualified engineers, a result that could hardly be more than temporary, yet one which it seems to be feared by *Engineering* would become a protracted embarrassment. It cannot of course be the purpose of any one to advocate a standard which will be prohibitive, and within reasonable limits, if the demand for qualified men prove greater than the supply, such an increase of pay would inevitably result in attracting more men to this calling in life, and an adjustment of supply to demand would follow in due course.

As to what may be gained by an extra two years spent in the machine shop, it is quite doubtful that such improvement in the qualifications of marine engineers would result as seems to be expected by the Institute of Marine Engineers. If the two years were occupied in work requiring the use of such tools and methods as marine engineers must employ on shipboard, some good might accrue from added experience and skill. In the shop, however, machine tools and other methods are the rule, and it is difficult to see how the desired improvement would be gained. It is very pertinently argued that "the engineering factories of the country are not run as educational establishments, and where the man is found to be most useful for forwarding work, there he will be put, even if he learns but the one job. Even articled pupils, with whom a stiff premium has been received, are apt to find difficulty in getting sufficient variety of work—much more so the class from which sea-going engineers are likely to be drawn."

The resolution originally adopted by the Institute of Marine Engineers was also referred by the Board of Trade to the North-east Coast Institution of Engineers and Ship Builders, and Mr. J. R. Fothergill was invited by the council of this institution to contribute a paper on the subject. Of this gentleman's qualifications for the discussion of the question, we are informed that "he has himself had large experience as a marine engineer, and has held important appointments as superintending engineer." Mr. Fothergill in his paper, among much other valuable suggestion, urged that "the present regulations of the Board of Trade met all requirements at the time when they were drawn up; but the march of progress has been rapid and the necessities of the case demand thorough, practical and technical knowledge; yet he asks does this demand upon the educational capabilities of a sea-going engineer require more than technical knowledge, namely, a useful knowledge of the principles that govern the general working of the machinery under his charge?" It is acknowledged that this is a difficult question to answer, and that the precise lines on which the education of marine engineers should proceed are difficult to define. As to the time spent in shop experience, it seemed to be the consensus of opinion expressed by those who discussed Mr. Fothergill's paper at the meeting when it was presented, that five years is the minimum that should be required. The proposition to grant third-class certificates was also much favored. Its intent and effect would be "to create a position and a status to many who have to wait long for promotion."

"An assistant engineer is not eligible for a second-class certificate until he has been twelve months in charge of a watch, and in large mail steamers he may have to wait years for his opportunity; whereas a younger and less experienced man may join a smaller vessel in which there are only three engineers, so that after but twelve months' experience he may become eligible for the second-class certificate.

"Mr. Fothergill did not propose that the third-class certificate should be compulsory to all engineers, but that in all foreign-going steamers carrying four or more engineers, or in all steamers of 300 horse-power nominal and upwards, the third engineer should hold a certificate. He suggests that the third-class certificates should be granted on examination after one year's sea service, and it is also proposed that the period of sea service for a second-class certificate should be altered from one to two years. These recommendations will, we think, be accepted as sound by most persons who have had actual experience in these matters. It is also proposed that the fact that an engineer should 'have served at least four years at sea in the engine-room as an engineer on regular watch in the foreign, home or coasting trade,' should not—as in accordance with the present Board of Trade regulations—entitle him to become a candidate for a second-class certificate."

As a result of Mr. Fothergill's paper and the discussion it elicited, resolutions were adopted, recommending to the Board of Trade, the granting of third-class certificates (not however, to be made compulsory to all engineers); that on foreign-going steamships of 300 nominal horse-power and upwards, the third engineer shall be a certificated engineer; that each candidate for third-class certificates shall have served twelve months at sea; that each candidate for a second-class certificate shall have served two years at sea, and that clause 3, par. 35, in the present Board of Trade regulations (which entitle an engineer after having served four years at sea in the engine-room as an engineer on regular watch in the foreign, home, or coasting trade, to become a candidate for a second class certificate) be annulled.

Breakdowns of Steamer's Machinery.

A LONG list of accidents to marine engines and machinery on ships, compiled from newspaper reports, confessedly incomplete, and also unclassified, is given by a writer in *Fairplay*, Nov. 9. The list covers a period of twenty months beginning with January, 1893, giving the names of vessels, and in most cases the nature of the injury; though only the names of vessels whose machinery was disabled (without stating the nature of the disability) are given in quite a number of instances. The variety of accidents to which steam machinery for marine use is liable, is, however, well displayed in this compilation, and a comparison of the number of accidents of each kind with that of others will fairly show which are the most frequent.

Thus out of a total of 129 disabilities, the particular nature of 106 are named. In a few cases, two of these disabilities occurred simultaneously on the same ship, and in the most of the cases classified below the ships were so much disabled as to compel them either to put in, or be towed into the nearest available port. We have arranged these in groups from the general list as given.

The list includes 43 broken shafts; 31 broken or lost propellers; 7 broken, cracked, or otherwise injured cylinders; 2 boilers burst, and 5 leaky; 4 broken crankpins, 3 broken crank arms, 3 broken down pumps and one condenser; 1 leaking steam pipe; 1 burst steam pipe; broken eccentric rod, eccentric, piston rod, connecting rod, and crown wheel, of each 1; 2 pistons broken; 1 rudder post broken; 1 steering gear broken down; 1 furnace disabled; 2 feed pipes disabled; 23 the nature of whose disability is not named.

The most frequent breakage is that of shafts. Next in order are propeller breakdowns and cylinders. The steam generating apparatus makes a very favorable comparison with the engines and propeller machinery, though in the popular mind the former is looked upon as the most frequent source of accident. The frequency with which shafts break down seems to prove either that their manufacture has not been brought to a desirable degree of perfection, or that their designers too frequently fail to give them the proper size needed to meet all the strains to which they are to be subjected.

Surface of Thrust Blocks.

A USEFUL diagram with accompanying explanation, by Geo. R. Bate, Assoc. M. Inst. C. E., is presented in the *Practical Engineer* for Nov. 2. "In its construction the effective horse-power, or the power actually employed in propelling the ship, has been assumed to be equal to two-thirds the indicated horse-power of the engines so that if

I.H.P. = the indicated horse-power of the engines

E.H.P. = effective horse-power = I.H.P. $\times \frac{2}{3}$

K = speed of vessel in knots

T = total thrust, or load on thrust block in lbs.

P = pressure on thrust collars, lbs. per square inch

S = surface of thrust collar, square inches per I.H.P., then

$\frac{K \times 6080}{60} = K \times 101.3$ = speed in feet per minute,

and work done per minute in foot-pounds.

$= T \times K \times 101.3,$

so that $T \times K \times 101.3 = E.H.P. \times 33000$;

therefore $T = \frac{E.H.P. \times 33000}{K \times 101.3}$,

Again, if $E.H.P. = \frac{2}{3} I.H.P.$,

we may write $T = \frac{2\ I.H.P. \times 33000}{3\ K \times 101.3}$

$$= \frac{I.H.P. \times 22000}{K \times 101.3} = \frac{I.H.P. \times 217}{K};$$

therefore S, the surface of thrust collars in square inches per I.H.P.,

$$= \frac{217}{K \times P}.$$

"The diagram gives the value of S with P, varying from 30 lbs. to 80 lbs. per square inch. In ordinary practice this pressure is 50 lbs. to 60 lbs. per square inch in naval work, and 40 lbs. to 50 lbs. per square inch in mercantile steamers, although in cases where white metal is fitted, it is found that these loads may be safely increased by 25 per cent.

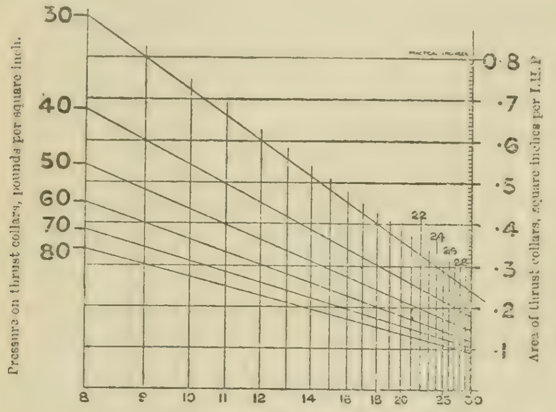


Diagram giving thrust surface per I.H.P for speeds of vessels up to 30 knots at various pressures between faces.

"As an example, let us suppose a case of a thrust block for a vessel having engines of 3000 I.H.P. driving her at a speed of 18 knots, and we require to determine the necessary surface of thrust collars, that the pressure on them may not exceed 60 lbs. per square inch. At the point marked 18 knots on the scale for speed of vessel, follow the ordinate up until it cuts the line marked 60 on the scale of pressures on thrust collars to the left of the diagram, at which point of intersection follow to the right, and read off the corresponding surface of collars per I.H.P.—*i.e.*, 0.201 square inches; then $0.201 \times 3000 = 603$ square inches, the total thrust surface required for $E.H.P. = 3000 \times \frac{2}{3} = 2000$

and $\frac{2000 \times 33000}{18 \times 101.3} = T$,

the load on the block = 36180 lbs.; then, if pressure per square inch between surfaces is not to exceed 60 lbs., we have total surface of block

$$= \frac{36180}{60} = 603, \text{ as by the diagram.''}$$

Economy of Triple Screws.

THE second meeting of the Society of Naval Architects and Marine Engineers was held on the 16th Nov. at the auditorium of the Am. Soc. of Mechanical Engineers, and its proceedings comprise a great deal of good work. A report of the meeting was printed in *American Machinist*, Nov. 22.

Passing over the able address of Presi- C. A. Griscom, the subject of greatest importance presented at the meeting seems to be the economy of triple screws, discussed by Commodore George W. Melville, Engineer-in-Chief, U. S. N., who claims the honor of recommending the use of this system of propulsion on the new U. S. cruisers *Columbia* and *Minneapolis.* The system, however, was not new when thus urged upon the consideration of the Navy Department.

"Although I had the honor of recommending the use of triple screws on these vessels, it is hardly necessary to tell this society that the use of triple screws was not a novelty, and that any credit in the matter arises simply from their use for machinery of much greater power than had previously been attempted, and for persisting in the design against the advice of some of my best friends in the profession, who believed it too much of an experiment.

"When I was asked to design machinery of about 21,000 I. H. P. for the *Columbia*, there were a number of questions which came up for consideration. One was that of securing economy at moderate speeds when full speed was so high, and another was that of the shafting. When the design was under consideration no steel shaft had yet been made in this country for the transmission of so great a power as 10,000 horses, and while I had every confidence in my friend, John Fritz and the Bethlehem Iron Company, I felt that it would be safer to adopt a design which would give us smaller shafting. The alternative to triple screws was twin screws, either with one very large engine, or two smaller ones on each shaft; the former meant large parts of the machinery all through, and the latter great multiplication of parts."

A speed of 22 knots per hour with 21,000 I. H. P. was all that was hoped for with these vessels, and no increase of economy in propulsion was expected; but on trial the *Columbia* made 22.8 knots per hour on 18,500 I. H. P. thus demonstrating the wisdom of Commodore Melville's recommendation, and a further gratifying fact is that a gain in economy has been reached at maximum power. Although this system has thus far only been tried with warships it is not likely to stop there. Commodore Melville thinks that the arrangement of screws commends itself for all very high speed ships, and says "if it were not dangerous to prophesy, I should be prepared to anticipate the adoption of triple screws for all the new 'flyers' that enter for the transatlantic race."

The cause of the increase of economy at maximum powers will excite inquiry. To account for it, it is explained that "the most reasonable explanation of the increased economy of propulsion is that, in an unusual degree, the center screw, which occupies the same position as the propeller in single screw vessels, profits by the forward motion of the frictional wake, and this without interfering with the stream line motion sufficiently to increase the vessel's resistance." To some of the fossil remains of a former age in marine propulsion, present at the meeting of the society, this explanation did not seem altogether satisfactory.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*26681. Address of the President, Thomas Sutherland, before the Institute of Marine Engineers (M E–Nov. 1.) 4000 w.

*26717. Steam Pipe Explosions on Ship Board (E–Nov. 2.) 3300 w.

26729. The New Launch for the Cornell University Crew. Ill. J. C. McMynn (E E–Nov.) 700 w.

*26735. Surface of Thrust Blocks. George R. Bate (P Eng–Nov. 2.) 200 w.

26798. The St. Louis Successfully Launched (Sea–Nov. 15.) 3000 w.

26825. The Proposed United States Torpedo Boats, with Editorial. Ill. (Ir Age–Nov. 15.) 3800 w.

*26977. Breaksdown of Steamer's Machinery (F'y–Nov. 9.) 2000 w.

27009. Hydraulic Steering Gear on the U. S.S. "Olympia." Ill. (Ir Age–Nov. 22.) 2000 w.

*27013. The Free Port of Copenhagen. Ill. (Tr–Nov. 9.) 3500 w.

27023. Hydraulic Power for Warships. (Abstract.) Albert W. Stahl (E N–Nov. 22.) 3500 w.

27024. Torpedo Launch for the U. S. Battleship "Maine." Ill. (E N–Nov. 22.) 1600 w.

27026. Second Annual Meeting of the American Society of Naval Architects and Marine Engineers, with Review of Leading Papers (A M–Nov. 22.) 5000 w.

*27040. The Proposed Cardiff Harbor Trust and South Wales Dock Extension. Ill. (Eng L–Nov. 16.) 4000 w.

*27089. The Training of Marine Engineers. Editorial (E–Nov. 16.) 3800 w.

*27185. Rules, etc., for Designing Screw Propellers. Ill. M. J. K. (M W–Nov. 23.) 500 w.

*27253. Aluminum Torpedo Boats and Other Vessels (Inv–Nov. 24.) 1200 w.

27405. An Improved Sail System. Ill. H. C. Vogt (Sc A S–Dec. 8.) 1800 w.

Serials.

16636. Marine Engine Design (M W–Began Oct. 6, 1893—17 parts to date—30 cts. each).

21969. The Shark and the Sailor. Ill. A. Ewbank (I E–Began April 14, 1894—22 parts to date—45 cts. each).

26091. Some Points in Modern Marine Engine Practice (I & I–Began Oct. 12—7 parts to date—30 cts. each).

26182. Development and Construction of the Marine Boiler (M W–Began Oct. 19—2 parts to date—30 cts. each).

27100. The Manning of Sailing Vessels. By a Skipper (F'y–Began Nov. 16—1 part to date—30 cts).

27378. Water-Tube Boilers and Their Application to War Vessels. Ill. J. Nastoupil (A E R J–Began Dec.—1 part to date—30 cts).

MECHANICAL ENGINEERING

Losses in Boiler Practice.

In a paper read before the Engineers' Society of Western Pennsylvania, Nov. 15, and printed in the *American Manufacturer*, Nov. 23, Mr. Daniel Ashworth does not deem it necessary to enter upon a purely technical discussion but prefers to adopt a more popular style of treatment.

The effort is "to make the story so simple that every one, not necessarily an engineer or a technical scholar, can grasp it instantly," yet without depreciation of the importance of a thorough knowledge of technical principles. The proposition is made that the greater losses in boiler practice are directly chargeable to lack of intelligence and proper management in the boiler room.

"The development of boilers, together with furnaces and devices, all converging to a more thorough combustion and rapid steam generation, would certainly lead one to believe that a radical improvement in the way of economy of fuel would result. While, in a measure, in special cases and conditions, there has been some improvement, yet a careful review constrains us to believe that the results are far short of what would be expected, and this is demonstrated, not only by careful and elaborate tests, but, in addition, by close observations of regular, continuous operation."

Seeking for an explanation, it is found in the aggregation of small losses, which neutralizes the otherwise beneficial effect of improved appliances for steam generation. Furnace walls cracked and admitting streams of cold air, indifference to the necessity of keeping boilers clean inside and out, and lack of capacity in those placed in charge of boilers are among the sources of loss. Irregular and injudicious supply of fuel and water are also frequent faults. Gradual increase of demand for steam power often leads to over-taxed boilers always resulting in reduced economy.

As to power plants in city buildings a great fault is want of space. The boilers are thereby rendered difficult of access for inspection and cleaning; and the result is that these necessary functions are either performed in a perfunctory manner or are put off as long as possible, instead of being attended to regularly and systematically. It is pertinently queried "how could it be expected that boilers and furnaces could be kept in anything like proper order where every part is of such difficult access?"

"The revival of mechanical stokers, which have been lying dormant on the other side of the ocean for a number of years, has resulted in the development of a number of machines, each possessing its respective merits, not only as regards the machine itself, but in the type of furnaces that form a part of the same. But taken as a whole, the expectations of the most earnest advocates of these machines have not been realized, and the inherent weakness or defect which presents itself in the greater number of them is the large amount of incandescent fuel that is dropped into the ashpit during the process of dumping the bars, which is necessary at frequent intervals. This entails not only a loss of the very best fuel in the condition to produce the best results, but also wastes in the critical operation, a large volume of heat that should be retained and distributed to do effective work. The most earnest advocates of mechanical stokers recognize this, and it has become a matter of serious thought in considering this loss whether we are really better off than with first class hand firing or with a shaking grate. That there is room for radical improvement in this direction is beyond all question. Dispensing with the dumping process, carrying with it great masses of rich fuel, would be heartily appreciated by those who are earnest advocates of the stoking principle."

As to securing a higher grade of intelligence in persons placed in charge of boiler rooms and their numerous appurtenances, he effort to do this is not made because ntelligence costs more in point of wages han ignorance. It does not follow that gnorance is the cheaper purchase. Were his the case the same line of argument would prove that "it would be more profitable to have ignorance and its attendant waste surrounding us on every hand. If proprietors and progressive superintendents are willing, and I believe they all are, in general, to adopt mechanical devices when it is clearly demonstrated to them that their operation is such as is conducive to economy, and when they cheerfully place upon their plants, automatic dampers, shaking grates, water alarms, and such appliances, does it not seem to be a gross inconsistency that they halt, or hesitate, at least upon the question of a little investment for more brains and intelligence?"

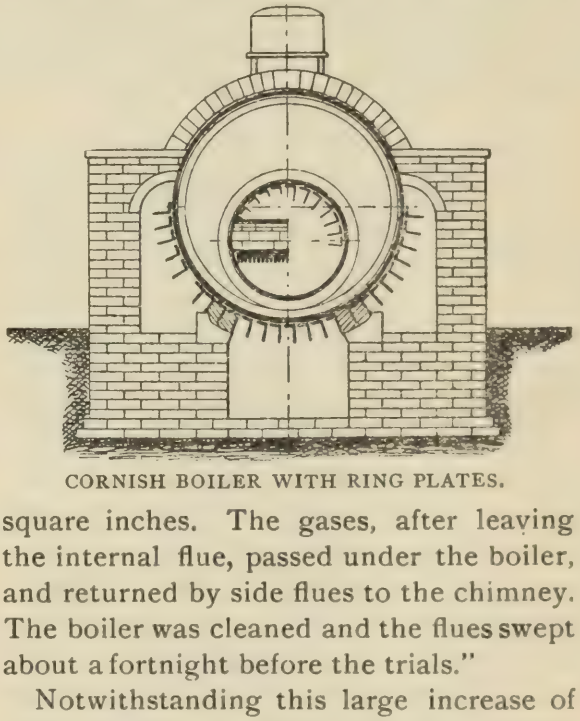
Evaporative Test of a Cornish Boiler.

THE particular test here referred to was made with a Cornish boiler fitted with heat conducting web plates, the object being to obtain experimental evidence as to the effect of extending heat absorbing surface on the side exposed to flame and hot gases, thus increasing the surface receiving heat materially over that imparting it to the inclosed water. The results were expected to give a more or less conclusive answer to the proposition that heat is much more rapidly taken by water from a given surface on the interior of a boiler than it is on the average, imparted by the gases of combustion to an equal extent of surface on the exterior. The test is described in *The Practical Engineer* (Nov. 16) by Michael Longridge, M. A.

The subject of the experiment was, "a Cornish boiler, 15 feet long by 5 feet 6 inches diameter, with one internal flue 2 feet 9 inches diameter. Both flue and shell were made up of six rings of plate. Upon these rings were riveted angle irons. The metallic surface in contact with the gases was increased by these angle irons from 256 square feet, which would have been the heating surface of the boiler had the angle irons been absent, to 772 square feet.

"The boiler was set in brickwork, and was covered on the top with ½ inch of sand, one layer of bricks on edge 4½ inches thick, and about 2 inches of composition, which was still wet when the trials were made. The brickwork and covering were exposed to the wind, the boiler being out of doors in a yard without any roof. The chimney was 33 feet high and 12 inches square at the top.

"The fire-grate consisted of 19 grate bars about 1⅛ inches wide by 3 feet long, and of a dead plate 14 inches long, pierced with twelve holes 1 inch diameter, for admission of air. The fire-door and furnace front were pierced with thirty-one holes, having an aggregate area of 6.6 square inches; and in addition there were two air conduits, one on each side of the fire-door, each of which had an area of 10 square inches. The gases, after leaving the internal flue, passed under the boiler, and returned by side flues to the chimney. The boiler was cleaned and the flues swept about a fortnight before the trials."



CORNISH BOILER WITH RING PLATES.

Notwithstanding this large increase of heat absorbing surface it is stated that very little, if any, increase of evaporative power was realized; and as the advantage of extension of surface on what are known as the *Serve* tubes seems quite authoritatively established, a question arises as to what condition exists in the test under consideration that does not obtain in boilers with Serve tubes. The answer is found in the want of molecular continuity between the angle irons riveted to the plates of the Cornish boiler and the plates themselves. It is impossible to bring these irons into anything like such continuity by riveting them on, and this lack must certainly and greatly interfere with the conduction of heat from the riveted-on surface to and through the boiler plates. It is to be regretted that the evaporative capacity and efficiency of this boiler had not been determined before the angle iron extensions were riveted on, so that the exact measure of increase of evaporative power, if any, could have been determined. The position of the angle irons riveted on the shell is well illustrated in the cut, as also their arrangement in the flue. Probably most engineers will, on inspection, fail to see in the arrangement much analogy to the *Serve* tube boilers, and would in advance expect just such a negative result as was obtained in the test. It would not be a matter of much surprise to learn that the result of such a test showed even diminished efficiency as compared with the original boiler.

The Economics of Lubrication.

THE existing variety of opinion and action in the use of lubricants, is noted by way of introduction to an editorial on the subject of lubricants in the *Railway Gazette*. This is more particularly treated with reference to locomotive practice, but the "economics of lubrication" extends to all fields of mechanical industry; the faults in practice found in any one of these are those which may be looked for in any of the others. Since these faults do not generally originate either in the lubricants themselves, or in the constructions to which they are applied, but in human defects, among which ignorance and carelessness are included, and as remedies for existing faults must deal principally with the human side of the question, remarks pertinent to these as met with in any department of mechanical engineering are necessarily general in import and application.

As to the quality of lubricating materials, experience has shown that the best, even though high-priced, are the least expensive in the long run, or would be so if applied economically. The wastes in lubrication are, however, enormous in practice, and there is no justification or valid excuse for the fact. "Every man should be well drilled in the use of lubricating material." Of course proper provision for economical lubrication should be supplied in all machine construction.

"Aside from good mechanical condition of the parts to be lubricated, we should of course have the best form of oil cups and feeders, so that the flow will be regular but only as fast as the service requires. There are many forms of these, especially for locomotives, which will do their work properly if well cared for. All oil packing receptacles like journal boxes should be tight and protected by proper covers and guards, so that there shall be the least loss of material and the least influx of dust and dirt."

But when the best appliances and the best lubricants obtainable are provided, only the possibility of economical lubrication exists; the probability of wasteful use is to be considered from the human standpoint. It is natural for the average man to be wasteful in the use of what costs him nothing. The morality of economy, as a principle of action in all things, has rarely a place in the education of workmen.

"The amount of material used by one man in doing certain work may be 50 per cent. more than that expended by another under about the same conditions. Many of the bearing surfaces on locomotives have to be oiled by hand, so that there is a great chance for relative saving or loss under this head. A constant supervision on the part of competent inspectors is necessary (no matter what their position is called), to see that all concerned are using the best methods to get good results. As a rule, those who are zealous in the service welcome suggestions, while those who object are usually persons with whom there is need of reform. The work of the car-oilers, in packing and oiling at stations, of trainmen with hot boxes on the road, and the work of individual enginemen with their engines, must all be carefully watched until the practice is uniform and efficient, and then it has to be kept so. The inauguration of this class of systematic inspection, has resulted more than once, under our own observation, in nearly doubling the mileage of a certain amount of oil on both engines and cars. One valuable feature in testing special oils has often been to show the managing officers how far the work done by the oil originally in use could be extended by careful watching and drill of the men, without causing delays from poor lubrication."

The enforcement of discipline in the matter of lubrication is no easy task in any extensive establishment. "It is easier to get good lubricating material at economical prices than to get good men who will regularly practice economy with material which some one else pays for." The only adequate remedy for this will be the cultivation of the sentiment among workmen, that careless or wanton waste is on a par with careless statement of facts or willful and gratuitous falsification, and that these vices are equally dishonorable and degrading to the man who indulges in them.

A Convenient Degree Scale.

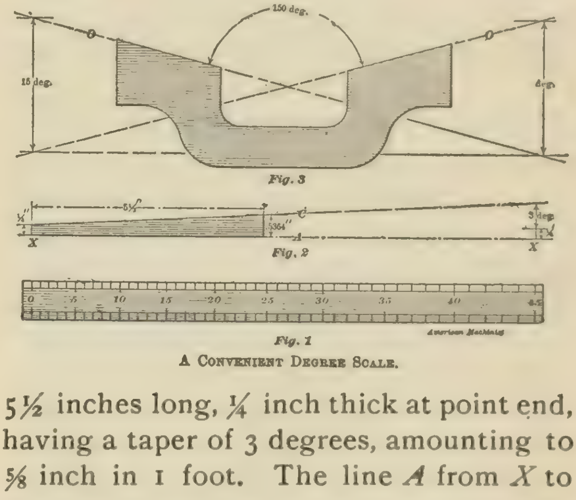
Mr. Francis W. Clough, has contributed to *American Machinist* a drawing of a very handy device which he has used as a substitute for a protractor and which he regards as much more convenient and accurate than any protractor or graduated Tee-square. This appears to be a real improvement. Mr. Clough is known to us as a man of such good mechanical judgment as to render valuable his opinion based, as he asserts, upon an experience of a number of years with the device in question. We herewith reproduce the drawing and an abstract of the descriptive text.

"Figure 1 represents the top of scale, showing the graduation; at the right is an end view; the length between the extreme or end lines is just 12 inches; a margin is left at each end of scale for protection of end lines.

"The graduations increase in each division from zero to 45 degrees, more perceptibly in the higher numbers than among the smaller number of degrees. The principle involved in its use is that with a 12-inch radius (24-inch diameter) measurement of angles to a greater accuracy can be obtained than with one ¼ or ⅓ that size, and yet the scale is far less bulky than a 24-inch diameter protractor. It is a well-known fact that certain angles can be quite readily obtained by measurement. As for example, a 45 degree line from a given point is quickly obtained by drawing two lines of equal length at right angles to each other, and joining the ends by a line. If one degree can be obtained by measurement, so any other degree in the circle may be as readily obtained if the proper measuring scale is at hand and understood.

"The method of using the scale is simply to measure off, say a horizontal line (though it may be a vertical line or oblique line) the length between the two end lines on scale = 12 inches; from that measure a vertical line from zero, the number of degrees desired, and connect the points by the oblique line.

"Figure 2 illustrates laying out a wedge 5½ inches long, ¼ inch thick at point end, having a taper of 3 degrees, amounting to ⅝ inch in 1 foot. The line *A* from *X* to *X* is 12 inches long; measure upon vertical line ¼ inch, the thickness of point of wedge; measure from the ¼ inch 3 degrees per scale, and join ends by a connecting line *C*, and we have a wedge 3 degrees taper.



A Convenient Degree Scale.

"Figure 3 illustrates further use of the scale. The lines *O O* make an angle of 15 degrees with the horizontal line; a recess is left in center of the figure. Now, to draw such a figure in outline, we may assume that the lines *O O* form an angle of 150 degrees, each 75 degrees from a vertical line, or 15 degrees from a horizontal line; the result would be all the same, and as easily obtained by the scale. I have had occasions to use this scale where a measurement of an angle was wanted with greater accuracy than could be obtained with the ordinary protractor.

"I am not, however, without protractors, graduated steel square and other means to obtain angles, and ordinarily use them, but this scale gets there closer than any of them when required. I can assure you it is a neat job to graduate one, and if the maker has only a two-foot rule and scratch awl at hand, he had better postpone the attempt."

Mr. Clough says that in graduating this scale he used a generating circle of 57.3248 inches in diameter. If, however, such scales came into general demand, it seems quite possible to construct a graduating engine that would do the work as accurately and cheaply as the graduation of other scales is now done, so that a scale of this kind could be afforded at a reasonable price.

Areas of Contact Between Wheels and Rails.

IN this department for November we reviewed two papers bearing upon the subject of areas of contact between balls and cylinders pressed against resisting plane surfaces. It seems that for some reason, considerable attention is at present directed to this subject in different quarters. The latest utterance we have seen is a communication from Mr. J. B. Johnson, to the American Society of Civil Engineers, printed in their September proceedings and reprinted in the *Railway Review*, Nov. 17. It includes a great number of diagrams giving outlines of areas of contact obtained by experiments performed five years ago.

"A section of a steel-rimmed locomotive driver 44 inches diameter and a section of a 33 inches diameter cast-iron car wheel were procured and mounted in a 100,000 pounds Riehle testing machine. Short sections of steel and iron rails were also procured and placed in the machine, so that the wheel treads rested upon them in a normal position. They were then loaded with 5000 pounds increments, from 5000 to 60,000 pounds, the area of contact being measured after each loading. The surfaces of the wheel treads and also of the tops of the rails were highly polished, so as to become good mirrors, before the experiments were made.

"The areas were obtained by marking with wet chalk the surface of the rail and rubbing it down, with a moistened finger and allowing it to dry. This gave a whitish appearance to the surface, with no appreciable thickness of film, and the actual area of pressure contact was clearly shown by a slight discoloration of this surface. A pencil line was passed around the border of this contact area, and then the area copied on tracing paper. The surface was then cleansed and examined for permanent distortion, and prepared for another loading. No permanent distortion was noted upon either rails or wheels at the contact surface up to the 60,000 pounds limit. At this loading, however, the web of the rail was observed to take a permanent set."

The plottings of areas obtained with different pressures strongly indicate that the areas vary directly as the pressures; or, as Mr. Johnson states it, "the load divided by the area of contact, or the average stress per square inch over the area of contact is a constant for all loads." He finds this constant to be about 80,000 pounds per square inch, "but the distortion or compression of the surface at the center of these areas of contact is just twice the average distortion over the area, and since the loads seem to be within the elastic limit of the material, it follows that the intensity of stress at the centers of these areas of contact was twice the average intensity of some 80,000 pounds for the steel driver upon a steel rail, or the maximum intensity of stress at the centers of these areas was for steel upon steel 160,000 pounds per square inch. For the chilled cast-iron wheel 33 inches in diameter this maximum intensity was still greater as the area was less. These areas were obtained by placing two cylinders in contact their axes being at right angles."

Mr. Johnson, in closing the communication, expresses the view that the analysis of these two cases, namely a cylinder upon a plane, and a sphere upon a plane, considering the stress distributed over the areas of contact according to the laws of the parabola and of the paraboloid, with due allowance for the distribution of the stress through the body of the roller, according to the laws already determined by Professor Marston, would show a close agreement between the computed and the actual areas of contact, and would serve as the last word on this subject from the mathematical point of view.

Facts About Bolt-Making.

THE importance as well as the difficulties of getting stock for bolts made of the proper size, to gage, are illustrated by a narration of the experience of a certain firm of bolt manufacturers which forms an introduction to an article by B. F. Spalding in *The Age of Steel.* This concern, using annually over a hundred tons of half-inch round steel in the form of headed bolts whose threads are to be cut in bolt cutting machines, and from ½ to 6 inches long under the head, found the greatest obstacle to their success lay in the imperfect rolling of the iron. An amusing as well as instructive story is that of their inexperience up to the time when it merged into experience ripe enough for them to accept the advice of their superintendent and insist upon getting the stock made to a gage supplied by the latter. Manufacturers urged that it was not " practicable to roll iron any better, any rounder, or any nearer to the gage " than they were doing. The proprietors of the establishment referred to, bringing this statement before the superintendent, he replied :

" It is impracticable, perhaps, for the workmen to roll the iron properly and to the correct size in the rolls which they have to use and for the wages they receive ; but if the mill owners will keep their rolls in repair, and pay the men by the day, it will be practicable enough to get iron perfectly round and accurate in dimensions. It is done in other countries. The iron we imported from England was round, and if you will look at the sample bolts which those bolt manufacturers sent, you will see that the iron they are made from is both round and of the right size. He went out into the blacksmith shop, and soon returned with a handful of short pieces of round iron, which he laid before the proprietors. Now, said he, you can see for yourself whether you would be willing to accept that kind of stuff as a proper legal fulfilment of the specifications of your contract for round iron. It is not picked out, but is a fair sample just as the man is cutting it off now at the shears." After an examination of the specimens they were at last convinced that the superintendent supported the right end of the controversy, and by dint of sheer persistence they " have for the last ten years obtained their stock quite round and correct in size." The result has been a great economy in the cost of manufacture.

" Very great improvements have been made in cutting threads on bolts, and yet whether they are cut with old-fashioned tools, stocks and dies in the blacksmith vise, or with the latest improved solid die bolt-cutting machine, the cold fact still asserts itself that it is extra work to remove extra stock.

" It is not probable that many dies for cutting threads will cut so clear, clean and free, that they do not in some degree raise the thread. Even in cutting a V-thread in the lathe, with a single pointed tool, this effect is observed. One of the best authorities on lathe practice makes this remark : ' As the cutting edge of the threading tool becomes dulled (and this occurs in some degree from the first instant the tool is put in use), its action partakes of the nature of forcing, as well as that of simple cutting the metal, and this induces the tops of the threads to raise slightly above the diameter of the work."

A comparison between bolts made prior to 1864 and those made at the present time indicates a very great improvement. In the year named the special committee of the Franklin Institute presented their report on the question of a proper system of screw threads. The simplification to a uniform standard thus secured is only one of many benefits conferred up on the mechanical industries of the country by the action and influence of the Franklin Institute.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

The Machine Shop.

26801. Construction of the Logarithmic Spiral. Ill. J. G. A. Meyer (A M–Nov. 15.) 2000 w.

26803. A Convenient Degree Scale. Ill. Francis W. Clough (A M–Nov. 15.) 500 w.

26804. Some Modern Shop Practice. Ill. John T. Usher (A M–Nov. 15.) 1400 w.

*26812. Moulding Condensers. Ill. (M W–Nov. 9.) 1200 w.

26821. The Manufacture of Burglar-Proof Vaults. Ill. (Sc A–Nov. 17.) 900 w.

26822. Portable Stone Dressing Machines of the American Pneumatic Tool Company. Ill. (Sc A–Nov. 17.) 900 w.

27001. Segment Work in the Pattern Shop. Ill. John M. Richardson (A M–Nov. 22.) 1600 w.

27099. Facts About Bolt Making. B. F. Spalding (A S–Nov. 24.) 2500 w.

27261. Points About Turret Lathes. James Hartness (M A–Dec.) 2200 w.

Steam Engineering.

*26708. Steam on Common Roads. Editorial (Eng L–Nov. 2.) 1500 w.

*26831. Standards Employed in Engine Testing. R. C. Carpenter (S J E–Oct.) 6000 w.

*26885. Locomotive Valve Setting. Ill. F. F. Gaines (S J E–Nov.) 23 0 w.

*26886. Comparison of Efficiencies of Common and Ball-Bearing Jacks. Ill. T. F. Ahern (S J E–Nov.) 2000 w.

26908. The Economy of Small Anthracite Coal. George H. Ward (H & V–Nov. 15.) 2300 w.

26937. Instructions to Boiler Attendants (S V–Nov. 15.) 2800 w.

27003. Apparatus for Testing Steam Gauges. Ill. James F. Hobart (A M–Nov. 22.) 3300 w.

27039. How to Run Steam Boilers (Eng–Nov. 24.) 2400 w.

27069. Losses in Boiler Practice and Some of Their Causes. Daniel Ashworth (A M & I W–Nov. 23.) 3000 w.

27072. Setting Engine Valves. Ill. Thomas Hawley (B J C–Nov. 24.) 2800 w.

27073. Two Cylinder vs. Three-Cylinder Compound in Mill Work (B J C–Nov. 24.) 1200 w.

*27129. Evaporative Test of a Cornish Boiler Fitted With Heat-Conducting Web Plates. Ill. Michael Longridge (P Eng–Nov. 16.) 2000 w.

27165. Steam Engine Fly-Wheels. William R. Kales (A M–Nov. 29.) 700 w.

*27184. Meldrum's System of Forced Draught. Ill. (M W–Nov. 23.) 700 w.

27189. The Standard Automatic Safety Throttle Valve. Ill. (Ir Age–Nov. 29.) 1800 w.

27195. The Chilling Action of Feed Water. Ill. (S E–Nov.) 2400 w.

27197. Some Leaks About the Plant. George West (S E–Nov.) 2000 w.

27199. The Circulation of Water in Horizontal Tubular Boilers. Ill. Charles Desmond (S E–Nov.) 2800 w.

†27228. Description of an Improved Steam-Separator and an Improved Steam Jacket. Ill. Charles T. Porter (A S M E–Dec.) 2000 w.

†27235. Experiments on a System of Governing by Compression. John H. Barr (A S M E–Dec.) 3000 w.

27265. Why Some Engines Pound. W. H. Wakeman (M A–Dec.) 1200 w.

*27267. Practical Steam Engineering (Eng L–Nov. 23.) 2800 w.

27275. Accounts of the Combined Turbine and Steam Plant of the Grosvenor-Dale Company. Ill. (E R–Dec. 1.) 1800 w.

*27283. Growth of the Steam Engine. Editorial (L E–Dec.) 1400 w.

*27322. Steam Engine Pathology (E–Nov. 23.) 1200 w.

27402. Multiple Expansion Diagrams. Ill. Charles M. Jones (A M–Dec. 6.) 2800 w.

*27443. Steam Power Plants for Flour Mills. F. Riddell (Am M–Dec.) 1800 w.

Miscellany.

*26710. General Meeting of the Institution of Mechanical Engineers, with Abstracts of Papers (E–Nov. 2.) 6000 w.

*26739. Gas Engines of Large Power. Ill. (R W–Nov.) 450 w.

26802. Why Does a Bicycle Stand Up? Oberlin Smith (A M–Nov. 15.) 2300 w.

*26833. Cableways for Handling Heavy Loads. Ill. William Hewitt (S–Nov.) 2500 w.

*26887. An Approximate Method of Rectifying the Circumference of a Circle. F. P. Stevens (S J E–Nov.) 700 w.

26930. Pumping Coal (R R–Nov. 17.) 800 w.

27002. Where and Why Compressed Air is Cheaper than Steam. Frank Richards (A M–Nov. 22.) 3000 w.

*27041. The Modern Development of the Gas Engine. (Abstract.) James Atkinson (Eng L–Nov. 16.) 1400 w.

27070. Gas Fired Glass Furnaces. Ill. (A M & I W–Nov. 23.) 1500 w.

*27081. Labor Saving Machinery (I C B–Nov. 16.) 1200 w.

*27102. The Maxim-Nordenfelt Gun Works. Ill. (I & I–Nov. 16.) 11300 w.

27166. Why Does a Bicycle Stand Up? J. Begtrup (A M–Nov. 29.) 1000 w.

27194. The Restoration of the Purdue Laboratory (S E–Nov.) 1800 w.

†27217. Trial of a Vertical Triple Expansion Condensing Pumping-Engine, at the Trenton Waterworks. Samuel Webber and S. S. Webber (A S M E–Dec.) 900 w.

†27218. Tests on the Triple Engine at the Massachusetts Institute of Technology. C. H. Peabody and E. F. Miller (A S M E–Dec.) 1000 w.

†27219. Trial of a Leavitt Pumping Engine. F. W. Dean (A S M E–Dec.) 1000 w.

†27220. Trials of a Recent Compound Engine with a Cylinder Ratio of 7 to 1. F. W. Dean (A S M E–Dec.) 700 w.

†27221. Comparison of the Action of a Fixed Cut-off and Throttling Regulation, with that of the Automatic Variable Cut-off on Compound and Triple Expansion Engines. Charles T. Porter (A S M E–Dec.) 1600 w.

†27222. On the Theory of the Moment of Inertia. C. V. Kerr (A S M E–Dec.) 4000 w.

†27223. A Graphical Method of Designing Springs. G. R. Henderson (A S M E–Dec.) 1000 w.

†27224. The Application of Brakes to the Truck Wheels of a Locomotive. Gaetano Lanza (A S M E–Dec.) 600 w.

†27225. An Experimental Study of the Effect of the Counterbalance in Locomotive Drive Wheels upon the Pressure between Wheel and Rail. W. F. M. Goss (A S M E–Dec.) 3000 w.

†27226. Description of a Cam for Actuating the Valves of High-Speed Steam Engines. Charles T. Porter (A S M E–Dec.) 2700 w.

†27230. Stresses in the Rims and Rim-Joints of Pulleys and Fly-Wheels. Gaetano Lanza (A S M E–Dec.) 4000 w.

†27238. Results of Measurements to Test the Accuracy of Small Throttling Calorimeters. D. S. Jacobus (A S M E–Dec.) 1900 w.

†27241. The Law of Invention. Horace Pettit (J F I–Dec.) 8500 w.

27245. Are Our Patent Laws Iniquitous? A Rejoinder. R. D. O. Smith (E E–Dec.) 5800 w.

27248. Wooden Pulleys. Ill. R. D. O. Smith (E E–Dec.) 1500 w.

*27259. A Compensating Planimeter. Ill. (C. G. Nov. 23.) 700 w.

27263. The General Principles of Machine Design. C. H. Benjamin (M A–Dec.) 1000 w.

27324. The Proposed Locomotive Tests at Purdue (R R–Dec. 1.) 2600 w.

27325. The McLaren Dust Shield and Journal Box. Ill. (R R–Dec. 1.) 1200 w.

27327. Fire-Box Construction. Ill. (R R–Dec. 1.) 1400 w.

*27392. The Wind in Harness. Ill. J. H. Campbell (Mill–Nov.) 2400 w.

*27394. The Cyclone in Harness.—The Pneumatic Steel Warehouse Company Elevator. Ill. (Mill–Nov.) 3000 w.

27404. The Relative Efficiency of Different Abrasive Products in Common Use. Charles N. Jenks (Sc A S–Dec. 8.) 3200 w.

27416. The Moore Trench Machine on the Greene Avenue Sewer, Brooklyn, N. Y. Ill. (E N–Dec. 6.) 1600 w.

*27442. Government Protection of Inventions. C. R. Tompkins (Am M–Dec.) 1100 w.

27452. Hints Upon Smokestacks. J. H. Allen (Eng–Dec. 8.) 1000 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters (M W–Began May 12—15 parts to date—30 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El–Began Dec. 1, 1893—26 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E–Began March—10 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L–Began Aug. 31—8 parts to date—30 cts. each).

25384. Spacing Holes. Ill. Easy Way (A M–Began Oct. 4—4 parts to date—30 cts. each.)

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Scheffler, Jr. (M A–Began Oct.—3 parts to date—15 cts. each).

25538. Testing of Engines and Boilers. Ill. Charles Day (P Eng–Began Sept. 21—6 parts to date—30 cts. each).

25922. Some Points in the Testing of Steam Engines (I & I–Began Oct. 5—5 parts to date—30 cts. each).

26181. Refrigerating Machines. Ill. A. R. Gale (M W–Began Oct. 19—Ended Nov. 16—5 parts—30 cts. each).

26463. The Slide Rule in the Shop. William Cox (M A–Began Nov.—2 parts to date—15 cts. each).

26488. American Steam Raising Plant (I & I–Began Oct. 26—Ended Nov. 9—2 parts—30 cts. each).

26590. Changing a Steam Plant to Improve Economy. Thos. Hawley (B J C–Began Nov. 10—Ended Nov. 17—2 parts—15 cts. each.)

26598. Fly-Wheel Accidents. J. J. Flather (E W–Began Nov. 10—Ended Nov. 17—2 parts—15 cts. each).

26661. The Selection of Motive Power. Charles E. Emery (E Mag–Began Jan—1 part to date—30 cts).

26752. The Cost of Steam Raising. J. Holliday (M W–Began Nov. 2—2 parts to date—30 cts. each).

26980. On Furnaces and Combustion (I & I–Began Nov. 9—1 part to date—30 cts).

27182. Notes on the Construction and Use of Pressure Gauges. C. R. L. Lemkes (M W–Began Nov. 23—1 part to date—30 cts).

27318. The Buckingham Works. Ill. (E–Began Nov. 23—1 part to date—30 cts).

27423. Repairing Steam Engines. Ill. T. W. Barber (S M–Began Dec. 1—1 part to date—15 cts).

MINING & METALLURGY

Chemistry of Iron.

FROM the chemical no less than the metallurgical point of view the condition and the effects of the various foreign elements present in iron and steel, either as impurities or purposely added, are always questions of the highest interest. Mr. John Parry has presented a notable paper on the subject before the South Wales Institute of Engineers, and his essay is reproduced in the *Iron and Steel Trades Journal*. It is impossible within the limits of a review notice to give an adequate idea of this paper in a popular form, and but a few of the points considered can be mentioned.

The author begins by saying that it is now generally admitted that when small quantities of foreign bodies, amounting in some instances to little more than traces, are added to iron its physical properties are thereby modified. "It would seem, however, that the part played by minute quantities of impurities in modifying the quality of iron is not easily explained by the ordinarily accepted theories of combination, solution or alloyage of one metal with another." The author points out that no reasonable formula can be assigned to a substance like ordinary steel, with 99 per cent. iron and the small and varying quantities of other elements, and yet that it is well known that minute quantitative differences in the relative amounts of these latter have a marked effect. Still, he believes, something akin to chemical combination must take place, since mere mixtures do not exhibit the phenomena of such combinations.

After remarking that it is not so long ago that the one-hundredth of a foreign element was disregarded by practical iron makers, the author proceeds to review some of the earlier hypotheses as to the constitution of iron and steel, which appeared to be endowed with peculiar physical properties not due solely to chemical variations. In consequence chemical analysis was considered as giving in most cases unreliable data, and that there were changes in physical properties to which analysis gave no clue. He considers it remarkable that the older metallurgists had really very nearly anticipated some of the theories recently advanced as to the allotropic state of iron. But the advent of the Bessemer process demolished earlier views by showing the necessity of ascertaining very accurately the chemical composition of the metal. Going to "what some are inclined to think" the opposite extreme, it was conceded that quality was practically a function of the composition of both iron and steel, while latterly there have been indications to modify this view. A plausible explanation of the discrepancies between chemical and mechanical tests may be found in the differences in temperature during manipulation. "At present there seems to be a common agreement that although the analysis alone is not reliable, and that the physical properties of steel are not always in accord with chemical analysis, yet the latter is an important factor which must not be ignored when endeavoring to forecast quality." In support of this the investigations of Webster are cited.

The relations of carbon to iron are peculiar, it conferring certain properties which do not pertain to other elements in steel; hence, as the author shows, while it is necessary in steels for certain uses where hardening, tempering and annealing are desirable (as in tool steel), in other steels (as for boiler and ship plates) it should be suppressed on account of unreliability. The three different states of carbon in iron and steel are described, and the author calls attention to the infusibility of carbon as placing it upon a different footing from the metals and metalloids, although later on he mentions the fact that the carbide of iron is the only compound yet isolated.

Mr. Parry goes rather deeply into the intricate subject of the relation of atomic weight to atomic volume, and the bearing upon percentage weights in the total composition of steel; and here he follows in the lines laid down by Roberts-Austen, but thinks that the practical application of these facts is difficult and that we have not yet sufficient data. "Throughout it appears that heat plays an important part in modifying not only temporarily, but permanently, the physical properties of the metal . . . and the relative chemical mobility seems a function of the temperature applied."

Finally the author suggests for discussion the revival of an old theory—that "steel may be regarded as an intimate mixture of pure iron with other chemical compounds, such as sulphur and phosphorus compounds. . . These alloys must as a rule be of a lower fusion point than iron and may serve as a species of flux or cement, binding the iron together."

Future Coal Fields of Great Britain.

SOMETHING of a revolution in the geology of coal, as currently stated in the text books, has been started by Professor Lapworth, who in a recent lecture has advanced certain propositions which, although recognized by field geologists, either do not appear in the books of reference or are passed over with scant comment. In this and in some other respects the elementary text books are at a disadvantage because of limited space in which to discuss questions about which there is at least room for argument, and also because of the desire (and perhaps necessity) of putting things in a hard, dogmatic form that can be grasped by young students and thus avoid the danger of confusing their impressions. An abstract of Professor Lapworth's lecture is given in the *Colliery Guardian*, and indicates that it is a noteworthy contribution to the literature of economic geology. "About a generation ago," the speaker pointed out, "it was believed that coal was only formed at one special period of the earth's history [omitting the Tertiary examples, which were then not prominent] but the discoveries of the last twenty years have shown that coal could be formed at any period, and in any region, wherever there existed those moist, warm and partially flooded conditions demanded for its formation." This appears axiomatic; but the issue hinges upon whether these favorable conditions existed only at certain definite periods or at any and all. As it happened that in Europe, where geologic science had its origin and where observations were most numerous, the coal beds were almost wholly of Carboniferous age, that age was thus named as the coal-forming age *par excellence*. Later when the lignites and brown coals of the western United States became prominent, a solitary exception was noted. Professor Lapworth goes a step farther, and after citing a long list of coal fields not of Carboniferous age comes out with a clear and frank expression of the most advanced geologic opinion: "Indeed," he says, "it may be regarded as certain that coal is being formed in enormous quantities at the present day in many, if not all, of the great flood plains and deltas of tropical and sub-tropical rivers." Selecting the great flood plain and delta of the Mississippi as an illustration of one of these growing coal fields, he showed how the natural phenomena of such a district might afford the requisite conditions for the formation of coal, in part from plants growing in place, and in larger part from washed-in material.

The leading *motif* of the lecture was the outlook for the future of British coal resources—a most critical question, for the commercial and manufacturing supremacy of Great Britain is based upon its available stock of fuel. Professor Lapworth believes that all the well-known data, practical and theoretical, point to the conclusion that all the Midland coal fields are merely the visible fragments of a single delta-like sheet largely buried beneath an overlying and continuous sheet of red sandstone, and that the coals must extend practically unbroken beneath this red sheet from coal field to coal field, within, however, certain original geographical limits beyond which coal would not be looked for, and he cites several observations in support of this view. "Every area in which coal might be expected must be carefully studied by itself individually, and only those spots selected for trial shafts which have the greatest number . . . of probabilities in their favor." To this might be added that, as the probable depths are so extreme, the diamond drill is the most economical means of exploration. Should Professor Lapworth's hypothesis of parallel conditions between British coal fields and others of later date and still forming hold good, a few test cores from any depth not mechanically prohibitive for mining—say down to 6000 feet or so—ought to show whether the coal, if it exists and is of workable thickness, can be profitably mined.

Chemistry in the Foundry.

SOMEWHAT similar to the early development of chemistry in blast-furnace work has been its recent history in the foundry—a gradual and at first slow departure from empirical methods, in which chemistry played little or no part, to a more systematic and scientific procedure. The *Engineering and Mining Journal* traces this analogy in evolution along similar lines; notes that early trial in the foundry, as in the smelting furnace, sometimes resulted in failure; alludes to the experiments of pioneer chemists, and takes pleasure in observing that progress is now rapid, although much remains to be learned in this direction. "One trouble," says the *Journal*, "has been that founders and others will not recognize that a knowledge of the chemical or physical features of either pig iron or castings is not sufficient," and points out that many small details of operating have much to do with the results, "Neither the chemist alone nor the founder can bring about the best work; it requires both in one, the chemical knowledge combined with the practical ability; and the latter is the result only of experience."

The Coolgardie Gold Fields.

AN interesting letter about this new gold district of Western Australia is copied by the *Australian Mining Standard* from the Bendigo *Advertiser*. The writer was there in the early period of the excitement and depicts the features common to all great mining rushes, to which are superadded some incidents peculiar to the arid region in which the new discoveries lie. His view is realistic and entirely conservative. "The exaggerated information about Coolgardie and the new finds, as filtered through the press, causes one to wonder when the boom will end and what will be the result. . . . Coolgardie and the surrounding gold fields are undoubtedly one of the best avenues for young men in Australia for advancement in life. They will have to take their chance; . . . but it is a strange fact that not more than one-third of the number that have arrived have remained. . . . New rushes are of almost weekly occurrence, but the great majority of them prove complete duffers."

A graphic pen picture is presented of a rush to one of the new finds, the "Wealth of Nations." It is hardly fair to condense this lively account into a few words, but the salient points may give some idea of how a rush is started and how it results: On the afternoon of mail day, when the crowd were waiting for letters at the post office at the main camp, a camel train was noticed coming in at a brisk walk until it stopped at the bank. Throngs gathered around to see what the loads were. The camels were unloaded, and it could be seen from the heavy pack bags that a large find had been made.—People flocked from all sides eagerly discussing the find and its probable locality. The discoverer was besieged by anxious questioners, but remained mute. After a while, an impromptu show was given in one of the rooms of the bank, to which the public were admitted in parties of six. A table was set out with some of the nuggets and rich rock. One piece, "Honest John," of 150 pounds "with gold standing out like peanuts from the quartz," was the chief attraction. Instantly the excitement increased and hurried preparations were made to set out in search of the "find," and parties of prospectors were out almost at once; but it was not until two days later that the way was made known. The course lay through an arid region where the only water to be had was at far separated "soaks" where the government had placed catchment tanks; so water was the principal freight carried. When the correspondent reached the place, water was selling at $1.25 a gallon. A patrol of troopers were out to keep order, but there were attempts at claim jumping. Small "alluvial" claims were rapidly staked off around the discovery point, and active digging began. As is usual, a very few men, a dozen or so, were successful, but the great majority found little or nothing. The gold hunters kept thronging in and going away disappointed, and the hardships were severe. "Nobody is considered anybody here," says the writer, "who has not done a 'perish,' that is, been without water five or six days." Evidently prospecting around Coolgardie is not exactly a "picnic," in either the literal or the slang sense of the word. From the time the letter was written until this notice of it appears some three months have elapsed, during which the cables have brought much later news, showing that things have settled down to more systematic shape, and while work is now on a more extensive scale the first wild enthusiasm has considerably toned down.

Electro-Deposition of Gold.

THE already extensive literature of the cyanide process has a recent addition in a paper contributed by Mr. E. Andreoli to *Elektrische Zeitung* and translated by the *Electrical Review*. The author begins by saying that to dissolve gold from its ores by means of a cyanide solution is one thing; to catch the dissolved gold is another thing, rather difficult, as gold cannot be precipitated from a cyanide solution by iron sulphate or sulphuretted hydrogen, as from a chloride solution. He considers the usual method of precipitation in zinc shavings as a crude one, which "ought soon to be replaced by a more rational and practical method of electrolytical deposition," and then refers to the Siemens electrolytic precipitation process, in which lead is used as a cathode. He considers the weak point in all such systems (including the mercury one) to be the important question of anodes, which does not seem to him to have been very successfully settled. He ridicules the idea of using zinc as an anode, mentions the use of carbon, and says that the question of iron anodes has not been well understood, studied or worked. The electrolysis of a very weak solution of potassium cyanide and gold comes to almost the same thing, he believes, as the electrolysis of plain water. Mr. Andreoli, commenting on a statement by another writer in regard to strength of solution, remarks that "electroplaters will be much surprised to learn that a weak solution is as good as a strong one." The Siemens solution is extremely weak and the intensity of current very low. The article contains sharp criticisms of other statements that have been advanced as to this process and is especially combative of a paper lately read by Mr. A. von Gernet before the Metallurgical Society of South Africa.

Coal Interests of Southwest Virginia, etc.

A CORRESPONDENT of the *American Manufacturer* who has just made an extensive tour of observation through the coal fields of southwestern Virginia, West Virginia, Kentucky and Ohio, makes an interesting report as to the probable future magnitude of the coal and coke production of that region and especially of the two Virginias, when the owners of the beds shall have constructed a few more lateral, tributary, branch railroads to tap the whole area. Already the coal and coke travel of the two main lines runs up into the millions of tons annually, although the industry is still in its infancy. These roads traverse what the writer believes will in a few years be conceded to be the greatest and richest field, in quantity and quality combined of the coals, in all the world. Up to 1880 the very existence of the important deposits of southwestern Virginia was not only unknown but denied on professional authority. At present numerous mines are in active operation and many are remote from each other, indicating values in the intervening areas yet unopened. In a little more than a dozen years scores of millions of dollars have been there invested in the building of railroads, towns and furnaces, the opening of mines, the construction of coke ovens near them and of wharves at seacoast terminals. The writer deals in strong statements, but disclaims any overestimate or exaggeration. The Imboden bed is described as 8 feet thick without a parting, and known to extend over an area of 50 or 60 square miles. Here a bench of 50 ovens is to be soon in operation as a beginning, to supply iron furnaces so situated that the ores, coking coals and limestone are in the immediate vicinity of each other. This (the Big Stone Gap) district is an example of others cited that are in the neighborhood. Near Colburn is the property of one coal and iron company having 55,000 acres of coal land in Virginia and 45,000 in Kentucky, and the product from only eight of its mines yet opened is 50,000 tons a month. Another company is building 400 coke ovens there. About 100 miles distant (with little mining being done now in the intervening space on account of the financial depression) is the Flat Top or Pocahontas field, so well known for its high-grade steam and coking coals and for its already great output. The correspondent could find no one to tell him just how many ovens were in operation, but saw " hundreds upon hundreds in full blast," and says that for miles the lateral ravines and gorges have been seized upon by coke burners. He gives a vivid description of what he saw: " Looking down upon such a scene as is here presented for miles, into the red-hot ovens, licking out their fiery tongues of flame, from amid the smoke and soot-blackened men moving hither and thither, one has a vivid realization of some of the scenes in Dante's ' Inferno.'" His language is not all so picturesque, as he gives many details of more practical import; but asserts that " centuries hence will hardly witness the exhaustion " of the Pocahontas beds, with their great area and thickness.

New Applications of Iron and Steel for Structural and Mining Purposes

AT the last conference of the British Iron Trade Association Mr. Jeremiah Head read a paper on the above subject. It is quoted in the *Iron and Coal Trade Review.* The author questioned whether as much had been done as might be in Great Britain to stimulate the demand for iron and steel in directions other than railways, shipbuilding and tin plates, which are three of the chief channels of consumption, and showed that in the United States and on the continent of Europe a great deal more had been attempted and achieved in the way of applying iron and steel to other and more general uses, more especially in substitution for timber, bricks and stone. The paper first deals with the use of iron and steel for public and private structures, in which wrought and cast iron have been used for beams and columns and now steel is used not only in floor beams and columns, but also in the frames of windows, roof work, supports for roofs, and even in the foundations in connection with concrete—in fact in everything that assists in carrying weight, so that many buildings are practically all-steel structures. The full extent of this movement is difficult to estimate, but Mr. Head mentions the large number of American iron and steel companies that are giving more attention to structural steel than to any other branch. More than 20 per cent. of the total production of steel ingots in the United States is now absorbed in the structural specialties.

Another great prospective use for steel is in the construction of railway cars, in which timber is expected to be supplanted by steel not only for the under frames but for the entire framework. Mr. Head estimates that there are now at least 2½ million vehicles of all kinds on the railroads of the world, not counting locomotives. The maintenance and increase of this stock represents, he thinks, a certain positive demand upon which the steel industries may safely reckon. The suggestion of Mr. A. E. Hunt to use an iron-aluminum alloy for this purpose is referred to, with the remark that the difference in price will for some time to come prevent that alloy from being placed in favorable competition with steel.

The use of iron or steel for shaft frames and props in French coal mines is said to be becoming very general. " Here again," says Mr. Head, " is an application from the adoption of which in Great Britain and some of its dependencies a new demand may be expected. The extent to which timber is used in mining is enormous, and if only it could be shown to be of advantage to substitute steel its use would rapidly extend. The cost of steel is lower in England than in France, so that if it pays to adopt it in the latter country it would be still more likely to pay in the former." [Here is food for thought for managers of mines in some parts of the United States, where timber is dear and steel, relatively speaking, cheap.]

Besides the cases mentioned at some length, the author remarks that there are many others in which the use of steel might be introduced or extended with advantage, as for ornamental purposes, for balconies, doors, windows, conservatories, fencing and a multitude of other uses. He calls attention to the pains and expense incurred by the German Iron Trade Association in publishing a work designed to bring under the eye of all who are concerned in building operations the advantages to be gained by the substitution of steel, which is thought to have already had the effect of directing more attention to the subject and of enlarging the area of steel consumption for constructive uses.

Losses in the Fire Assay.

In a paper read at the October meeting of the American Institute of Mining Engineers Mr. H. V. F. Furman discusses the question of losses in the fire assay for gold and silver. The purpose of the paper is to call attention to the desirability of more uniform methods of assay. The sources of error, the author points out are improper sampling, losses of the precious metals during fusion, scorification and cupellation, imperfect elimination of the base metals in the cupel, and imperfect extraction of the silver in the parting by nitric acid. Of these losses that during fusion is the greatest source of error. In cupellation the temperature is a more important factor than the quantity of lead or of base metals other than lead. The difficulty of removing the last traces of silver from the gold is recognized, and the author suggests certain precautions in parting. A table is given showing the results of experiments to determine the losses in the crucible assay of ore.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

*26498. Chemistry of Iron: Modern Practice. John Parry (I & S–Oct. 27.) 3300 w.

26521. Losses of Gold and Silver in the Fire Assay Howard V. Furman (E M J–Nov. 3.) 700 w.

*26682. Presidential Address of William Jacks to the British Iron Trade Association (I C T–Nov. 2.) 3600 w.

*26683. New Applications of Iron and Steel for Structural and Mining Purposes. Jeremiah Head (I C T–Nov. 2.) 2200 w.

*26684. Special Conditions Affecting England's Iron Trade with India. Jeremiah Lyon (I C T–Nov. 2.) 3700 w.

*26685. The Scotch Pig-Iron Trade. A. B. Low (I C T–Nov. 2.) 2500 w.

*26704. The Atlas Works, Sheffield. Ill. (Eng L–Nov. 2.) 2000 w.

*26719. The Cost of Gold Milling. Editorial (M J–Nov. 3.) 1800 w.

26862. Melting Tin Plate Scrap in a Cupola. Edward Kirk (Met W–Nov. 17.) 1600 w.

*26965. Effects of Metals and Metalloids on Iron and Steel. Harry Silvester (P Eng–Nov. 9.) 2000 w.

*26975. Changes in Iron and Carbon During Tempering. George Charpy (C G–Nov 9.) 600 w.

*26979. Electro-Deposition of Gold. E. Andreoli (E R L–Nov. 9.) 1800 w.

27011. Preliminary Tests on the Strength of Copper. A. Martens (Ir Age–Nov. 22.) 2000 w.

27012. Malleable Castings from Coke Iron. Editorial (Ir Age–Nov. 22.) 900 w.

27021. The Present Status of Face-Hardened Armor (Abstract) W. T. Sampson (E N–Nov. 22.) 1800 w.

*27043. The Cyanide Case. Editorial (Eng L–Nov. 16.) 1200 w.

*27051. Wet Iron Ores and Their Metallic Values. Walter J. May (C G–Nov. 16.) 800 w.

27059. The Crystallization of Iron. H. M. Howe (E M J–Nov. 24.) 2500 w.

27063. The Wentworth Goldfields Proprietary Company's Stamp Mill at Lucknow, New South Wales, Australia. F. M. Drake (E M J–Nov. 24.) 800 w.

*27082. Tempering Tool Steel. F. M. S. (I C B–Nov. 16.) 1000 w.

*27104. The Condition of the Iron Trade of Great Britain (I C T–Nov. 16.) 1800 w.

*27105. Different Types of Basic Open-Hearth Steel Furnaces. Bernard Dawson (I C T–Nov. 16.) 3800 w.

*27106. An Important Field for Blast Furnace Economy. Editorial (I C T–Nov. 16.) 800 w.

*27127. Cyanide and Electrolytic Cyanide Solutions. Emile Andreoli (E R L–Nov. 16.) 2500 w.

27138. The Antiquity of Iron and Steel. G. D. Hiscox (Sc A–Dec. 1.) 1500 w.

†27151. The Electro-Metallurgy of Gold and Silver. A. L. Eltonhead (P E C P–Nov.) 2700 w.

27186. Comparison of Strength in Specialty Mixing of Cast Iron. Gus C. Henning (Ir Age –Nov. 29.) 1500 w.

27188. How Shall We Gauge Wire and Sheets? Oberlin Smith (Ir Age–Nov. 29.) 4800 w.

27205. Determination and Detection of Copper. M. Haupt (E M J–Dec. 1.) 1300 w.

27212. Report of Committee on Comparison of Round and Square Test-Bars, with Discussion (I T R–Nov. 29.) 4800 w.

†27229. Notes on Steel Forgings. G. M. Sinclair (A S M E–Dec.) 2800 w.

†27231. Report of Committee on Uniform Methods of Testing Materials. Monograph of W. J. Keep, Covering Relative Tests of Cast Iron, with Chemical Determinations of the Fourteen Series, by R. N. Dickman (A S M E–Dec.) 4500 w.

†27236. Rustless Coatings for Iron and Steel Galvanizing, Electro-Chemical Painting, and Other Preservative Methods (2d Paper). Ill. M. P. Wood (A S M E–Dec.) 21000 w.

27308. The Blast Furnace. E. C. Potter (C M R–Nov.) 2400 w.

†27315. Some Recent Contributions to Our Knowledge of Metallic Reducing Agents. H. F. Keller (J A C S–Dec.) 3900 w.

*27320. The Stora Kopparbergs Bergslags Aktiebolag. Ill. (E–Nov. 23.) 2000 w.

*27323. The Early History of Crucible Steel. R. A. Hadfield (E–Nov. 23.) 5000 w.

27395. Malleable Castings from Coke Pig Iron. Ill. (Ir Age–Dec. 6.) 600 w.

27448. Dressing Spathic Iron Ore at Allevard (E M J–Dec. 8.) 1000 w.

Mining.

26523. Gold Mining in Ecuador. A. F. Saabye (E M J–Nov. 3.) 1300 w.

26679. Coal Interests of South Western Virginia. J. D. Imboden (A M & I W–Nov. 9.) 3000 w.

*26697. Coal Mining in the Transvaal (C G–Nov. 2.) 1000 w.

*26698. Newfoundland: Its Geology, Useful Minerals and Mining Legislation. M. de Launay (C G–Nov. 2) 1400 w.

*26699. The Coal Trade of the East (C G–Nov. 2.) 1100 w.

*26718. West Australian Gold Fields.—Interview with W. H. Webb (M J–Nov. 3.) 2400 w.

*26732. Explosives for Mining Purposes. Editorial (P Eng–Nov. 2.) 900 w.

*26773. An Expert's Opinion on West Australian Mines (Min W–Nov. 3.) 1700 w.

*26834. Stones of Sweden. (Extract.) Hjalmar Lundbohm (S–Nov.) 1800 w.

26868. Waste of Coal in Mining. Selwyn M. Taylor (E N–Nov. 15.) 2000 w.

26911. The Harney Peak Tin Mines. Ill. Arthur J. Morse (E M J–Nov. 17.) 700 w.

*26925. Future Prospect of the Thames (N. Z). J. Park (A M S–Oct 6.) 1300 w.

*26926. The Mitchell's Creek Freehold Gold Estate, Wellington (N. S. W). Ill. (A M S–Oct. 6.) 1000 w.

*26927. The Coolgardie Goldfield (W. A.) An Interesting Letter (A M S–Oct. 6.) 2000 w.

*26928. The Croydon Goldfield (Q.) (A M S–Oct. 6.) 1500 w.

26938. Cost and Efficiency of Underground Pumping Engine (S V–Nov. 15.) 1200 w.

*26940. Consolidated Gold Fields of South Africa.—The Director's Report (M J–Nov. 10.) 1500 w.

*26941. The Boom in Gold Mining. Editorial (M J–Nov. 10.) 700 w.

*26959. Coal Mining and the Health of Miners (I C T–Nov. 9.) 2000 w.

*26972. An Interesting Coal Pit (C G–Nov. 9.) 900 w.

*26973. Our Future Coalfields (C G–Nov. 9.) 1000 w.

*26974. The Aerial Rope System of Transport in Victoria (C G–Nov. 9.) 1400 w.

*26976. Mines and Minerals in Scotland—Review of Book by D. Ross Stewart (C G–Nov. 9.) 3000 w.

†26991. Our Indian Mining Letter. Lepidodendron (I E–Oct. 20.) 1100 w.

*26993. A Juggle.—Plain Words about the Consolidated Goldfields of South Africa (Min W–Nov. 10.) 1400 w.

*26994. A Remarkable Gold Mine—Londonderry (Coolgardie) (Min W–Nov. 10.) 1000 w.

*27000. Western Australian Goldfields. Editorial (E–Nov. 9.) 1800 w.

*27048. Cretaceous Coal in North America (C G–Nov. 16.) 900 w.

*27052. Disposal of Waste at the Pit-Head. Ill. (C G–Nov. 16.) 2000 w.

27061. The Coal Industry in Belgium During 1893. Emile Harze (E M J–Nov. 24.) 1100 w.

*27094. Chili as a Coal Producing Country (B T J–Nov.) 750 w.

*27107. Explosives for Mining Purposes (I C T–Nov. 16.) 2000 w.

*27112. Quarrying. C. Le Neve Foster (M J–Nov. 17.) 1800 w.

*27113. The Gold Output of the Witwatersrand (M J–Nov. 17.) 1000 w.

27155. Proceedings of the Annual Meeting of the California Miners' Association.—The Speeches, the Resolutions and the Suggested Changes in the United States Mining Laws (M S P–Nov. 24.) 12000 w.

27156. Mineral or Agricultural Character of Land.—Argument Submitted to the Congressional Committee on Mines and Mining (M S P–Nov. 24.) 6500 w.

27157. Department Rulings and the Miners. A. H. Ricketts (M S P–Nov. 24.) 3000 w.

27172. The Drainage Works of the Ontario Silver Mine, Utah. Ill. W. P. Hardesty (E N–Nov. 29.) 4500 w.

27203. The New Pedrara Onyx (E M J–Dec. 1.) 1000 w.

27204. Tin Mining in Perak (E M J–Dec. 1.) 1200 w.

27213. Mining Industries of Australasia Min R–Nov. 15.) 2000 w.

27306. Mining in British Columbia. H. J. E. (C M R–Nov.) 2400 w.

27307. Mine Explosions Generated by Grahamite Dust. Ill. William Glenn (C M R–Nov.) 5000 w.

27361. Minerals of Appalachian System. William Brewer (T–Dec. 1.) 1400 w.

27430. Continued Proceedings of the Annual Meeting of the California Miners' Association (M S P–Dec. 1.) 15500 w.

27431. Investments in Mines. C. W. Cross (M S P–Dec. 1.) 3300 w.

27432. The Successful Application of Electricity to the Operation of Mines. W. F. C. Hasson (M S P–Dec. 1.) 2500 w.

27433. The Hydraulic Gravel Elevator System in Hydraulic Mining. R. H. Campbell (M S P–Dec. 1.) 1400 w.

27446. Gold Deposits of Colombia and Ecuador. T. Waln-Morgan Draper (E M J–Dec. 8.) 1800 w.

Miscellany.

*26660. Laboratory Training for Mining Engineers.—The Course at the Massachusetts Institute of Technology. Ill. Robert H. Richards (E Mag–Jan.) 2000 w.

26815. In the Borax Marshes (M S P–Nov. 10.) 600 w.

*26951. Mineral, Metallurgical and Coal Industries of Sweden in 1893 (Eng L–Nov. 9.) 1500 w.

27004. A History of the Miners' Movement (M S P–Nov. 17.) 2300 w.

*27093. Development of the Russian Mining and Metallurgical Industries (B T J–Nov.) 1100 w.

*27393. November Excursion of the Western Society of Engineers.—Visit to the Illinois Steel Works (Mill–Nov.) 1800 w.

Serials.

☛19682. The Sinking and Equipment of Shafts. Ill. (E–Began Feb. 2—7 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng-Began April 27—10 parts to date—30 cts. each).

24075. Manufacture of Tin Plates (I & I–Began July 27—5 parts to date—30 cts. each).

26031. European Phosphates. C. C. Hoyer Millar (M R–Began Oct. 19—5 parts to date—15 cts. each).

26118. Iron Ores. John Randall (C G–Began Oct. 12—4 parts to date—30 cts. each).

26139. Aluminum. A. Humboldt Sexton (P Eng–Began Oct. 12—2 parts to date—30 cts. each).

26293. The Zinc Mining Industry of Southwest Missouri and Southeast Kansas. J. R. Holibaugh (E M J–Began Oct. 27—Ended Dec. 8—7 parts—15 cts. each).

26386. Proper Foundry Construction, and the Apparatus to be Used. Simpson Ballard (T–Began Nov. 1—3 parts to date—15 cts. each).

26556. The Phosphates of the World. Francis Wyatt (J F I–Began Nov.—2 parts to date—45 cts. each)

26561. The Cornwall Ore Hills. John Birkinbine (Ir Age–Began Nov. 8—3 parts to date—15 cts. each).

26687. The Coalfields of Labuan, Borneo. Robert Fisher (I C T–Began Nov. 2—Ended Nov. 9—2 parts—30 cts. each).

26690. On Nickel Steel. (I & I–Began Nov. 2—Ended Nov. 23—2 parts—30 cts. each).

26693. The Effect of Stress on the Corrosion of Metals. Thomas Andrews (I & I–Began Nov. 2—2 parts to date—30 cts. each).

26816. Notes on the Gold-bearing Black Sands of California. J. A. Edman (M S P–Began Nov. 10—1 part to date—15 cts).

26826. Open Hearth Steel. Ill. (Ir Age–Began Nov. 15—2 parts to date—15 cts. each).

26912. Historical Sketch of Lead and Zinc. Arthur Winslow (E M J-Began Nov. 17—Ended Nov. 24—2 parts—15 cts. each).

27049. Mining Plant at the Freiberg Exhibition. O. Lange (C G–Began Nov. 16—2 parts to date—30 cts. each).

27111. The Profits of Gold Mining. Nicol Brown (M J–Began Nov. 17—2 parts to date—30 cts. each).

27319. The Mineral Resources of the United States. (E–Began Nov. 23 —1 part to date—30 cts).

27329. Coal Mining Economy up to Date (I C T–Began Nov. 23—1 part to date—30 cts).

27356. Further Experiments in Amorphous Gold. Henry Louis (M J–Began Nov. 24—1 part to date—30 cts).

27357. The Practical Operation of the Cyanide Process on the Rand. M. Eissler (M J–Began Nov. 24—1 part to date—30 cts).

27358. Motive Power for Mining Machinery (M J-Began Nov. 24—1 part to date—30 cts).

27450. Cupola Tuyeres. Ill. Edward Kirk (Met W–Began Dec. 8—1 part to date—15 cts).

MUNICIPAL ENGINEERING

Utilization and Purification of Sewage.

In this department of our December number, was described a system of irrigation by sewage carried out at the city of Trinidad; and while it was stated that this was a new departure in the United States, reference was also made to the fact that the system had made considerable progress in European countries. A very comprehensive editorial in *The Engineer* (Nov. 9) not only indicates that this system has progressed to what may be properly called a somewhat extended use, but also lays down the principles which must be observed in carrying out the method in order that it may be successful in fertilization of the soil, and at the same time be regarded as safe from a sanitary point of view.

First, as to the time the system of fertilization by sewage has been in use, it may be said that it is of ancient origin, being "the oldest method adopted for dealing with a national and social problem, which, in point of magnitude, gravity, and urgency, has now assumed proportions that have rarely been equalled and probably never surpassed." More than three hundred years ago Bunzlau, in Prussia, disposed of its sewage in this way. Edinburgh, in Scotland, utilized its sewage nearly two centuries ago; and Milan in Italy, ranks nearly with Edinburgh in the early adoption of this method. In Asia, the use of sewage for fertilizing land was practiced earlier than in Europe.

Purification of sewage and its utilization are distinct methods, though both may be employed together. As to the question "whether the agricultural utilization of sewage should include a preliminary process of purification or clarification before it is passed on to the land (not necessarily by chemicals) is a subject concerning which engineers and scientists are not altogether agreed." When applied in the raw state it may be attended with danger to public health by saturating the soil with septic elements, and this is a question to be carefully pondered before adoption of sewage irrigation for any town, no matter how urgent the case may be. Whether this is likely to occur or not, depends somewhat upon the soil upon which the sewage is distributed; "but a great deal more upon the character and quality of the sewage itself." It is certain, also, that the manner of application of sewage to land has an important bearing upon the question of danger. A certain quantity varying with the nature of the land, can be absorbed. Any surplus over this remains to contaminate the immediate locality it may be to a dangerous extent. At Edinburgh, where raw sewage has for a very long time been applied to soil, evil results have not followed.

"It should not, however, be forgotten that this statement should be qualified by another, which is to the effect that the Craigentenny meadows are never allowed to be saturated persistently with sewage. When a sufficient quantity has been run on to them, the surplus is carried away to the sea. At Berlin, which, with its acquired land of 19,000 acres for sewage farms, is supposed to set an example to the rest of the world, both the broad irrigation and filtration principles are put into practice. A difference worth notice is made in the treatment of the plots upon which crops are grown and those used for the cultivation of grass. In irrigating the former, the sludge is allowed to pass on to the land with the sewage, and consequently remains there after irrigation, when it is ploughed deeply into the ground. In the case of the sewaging of the grass plots there are catch pits provided which intercept the sludge, as it was found that it clogged the surface and seriously interfered with the growth of the grass. When raw sewage is turned on to land the latter acts, no doubt, in the first place as a simple mechanical filter, leaving the heavier and coarser particles on the surface. The liquid portion which contains the dissolved ingredients and the lighter and smaller particles in suspension, penetrates into the soil, and thus accomplishes the double purification already referred to."

The sewage farms of Gennevilliers, near Paris, are said not to be regarded with the same admiration by French sanitary engineers as would be inferred from their frequent citation in argument by advocates of sewage utilization. French farmers however, who are thus enabled to raise profuse crops without paying for fertilizing material, are loud in its praise. The quality of Paris sewage, is however, very much better adapted to sewage farming than that of many other towns, in which discharges of various materials into sewers as wastes from manufacturing establishments are abundant. As illustrating the principle that quality has much to do with the practicability of this method of sewage disposal, the history of sewage works at Wolverhampton, England, is instructive.

" The sewage farm there was purchased some twenty-five years ago, and occupied a site possessing the advantages of receiving nearly all the sewage of the borough by simple gravitation. For some years the local authorities made most laudable attempts to effect agricultural utilization by means of the broad irrigation principle and that of intermittent downward filtration. Their efforts were unfortunately all in vain, and they were ultimately driven to the conclusion that precipitation, or a preliminary treatment of the raw material, in some form or another, must be undertaken before it could, with any beneficial results, be turned on the land. The fact was that the sewage was rendered so foul by the quantity of refuse, waste water, and by-products of the numerous trades and manufactures in the town and district that it was utterly unfit to be applied directly in its crude state to the soil. It was found that when the sewage of only fifty persons on one acre was the proportion employed, the purification effected was of most perfunctory character, notwithstanding that the percolation extended to a maximum depth of 6 feet. By excluding as much as possible the storm waters from the sewers, by the construction of precipitation works, by the erection of a plant for pressing and consolidating the sludge, and by the proper preparation of the quantity of land for the final treatment of the effluent, the Sewerage Committee has successfully overcome the difficulties formerly besetting it."

But a still worse set of conditions was encountered at Nuneaton, England. Here materials discharged into the sewage are positively destructive to vegetable life. Utilization for fertilizing is not attempted, but simply clarification to an extent that will permit the liquid to be discharged into the nearest stream. Precipitation by the lime and alumina process, followed by filtration through sand and polarite, are the means by which clarification is effected. The chemical treatment has sometimes to be repeated before the material is brought to a proper state for filtration.

The fact that chemical treatment does not always purify, but only clarifies sewage ought not to be overlooked. Mere clearness of the liquid is not complete evidence of its purification. As to the assertion that if in this state " it be discharged into a river, it will, after a brief period revert to the same condition of impurity and pollution as it possessed previously to precipitation," it is replied that " experiments conducted at Salford with polarite, and also with an electrolytic process, tend to rebut this theory." The electrolytic process promises well, but its cost is rather high.

Estimates of the extent of land needed for the complete utilization of the sewage of Paris and London have been made. For Paris the estimate made of 150,000 acres is thought in England to be largely excessive; and, based upon results at Berlin, an estimate of 60,000 acres is judged enough to utilize the entire sewage of London.

Color of Water.

THE objectionable appearance of potable water supplied to many cities is a matter of notoriety. This arises principally from the presence of vegetable matter, and in a paper on the subject by Desmond Fitzgerald and William E. Foss, in the *Journal of the Franklin Institute* for December, this subject is considered with reference to scales for measuring the amount of the discoloration. An example of such discoloration is met with in water taken from the Sudbury river which is one of the principal sources of supply for the city of Boston.

"The area of the water-shed above the point of taking, is about seventy-four square miles. On this area several large storage reservoirs have been built for the purpose of equalizing the yield of the streams. As the sites of the reservoirs have been mostly stripped of all organic matter the effect of storage is to reduce the color of the water delivered by the feeders, but as it is impracticable to keep the water stored long enough to decolorize it completely, much study has been given to the source and amount of the color delivered by the streams supplying the reservoirs, and it has been found, as was expected, that the swamps and meadows were the principal sources of color. In July, the color of the water coming from the swamps is a rich reddish-brown, and in autumn, after the leaves have fallen, the color has more of a greenish cast. The color of the brooks varies constantly during the year, depending largely upon conditions which cannot be now discussed. In winter the color is naturally low, in the spring the color is high, reaching its maximum in June, and a second maximum occurs in December.

"In making plans for the improvement and drainage of the swamps it became important to be sure of the measurement of the colors, and as the color of the Boston water is almost an exact gage of the organic matter which it contains, it also became important that the color of the water delivered to the consumers should be readily and accurately measured on some correct scale."

The method of transmitted light with what are known as nesslerized ammonia standards has been found for various reasons not to be satisfactory, and an attempt to replace them by natural water standards has proved the latter to be also open to objection. They do not change their color so rapidly as the nesslerized ammonia solutions do, but it is difficult to standardize them by the nesslerized solutions because of the difficulty of insuring similarity of conditions in preparing the solutions. Other difficulties were also encountered which, added to the one already noted, renders it desirable to seek a different standard. This has been found in the platinum standard recently suggested by Dr. Allen Hagan, originally described in the *American Chemical Journal,* Vol. XIV, No. 4. For the method of preparing this standard and its use, the reader must consult the paper itself, which contains also a great deal of useful information relative to this kind of work which will be highly serviceable to engineers in charge of water works, and is also of general scientific interest.

Improved Methods in Laying Asphalt Pavements.

FROM the annual report of Capt. Chas. T. Powell, Engineer Commissioner of the District of Columbia (300 pages) an extract on the subject named is printed in *Paving and Municipal Engineering.* This is of general import, and it contains information relating to a class of street improvements now in active progress in most of our large cities.

The proportion of stone dust in asphalt mixtures for paving should be considered with reference to the quality of the sand as relates to the size grains. The function of this dust is regarded by Mr. Powell as being to "stiffen the cement" in voids between granules. With the rather coarse sands of the Potomac river he has found it well to use 15 per cent. of stone dust, thus obtaining a "tougher and more desirable surface." To shorten the time heretofore needed in refining asphalt the following method has been adopted: "The departure has consisted in the use of high-pressure steam in large gangs of pipe as a source of heat and a jet of air or of live steam as a means of agitation of the mass of pitch, thus preventing the formation of a core and the overheating of that portion of the pitch adjacent to the shell of the still. A considerable saving of time and material has been accomplished in this way, but it is still an open question as to how the quality of the product will compare with the old process material. In this connection the form of test for refined asphalt of allowing a certain sized lump of the material to flow down an inclined glass at temperatures above its flowing point, side by side with certain standard pieces, which Prof. Bowen has developed, has proved of value, as it shows the relative softness of materials and smoothness or lack of impurities."

It is added that "the oiled asphalt has shown an improvement, being more uniform in consistency. The use of a new hot roller in front of the regular roller, which has been introduced as a substitute for the ordinary oiler hand roller, is stated to have proved a distinct advance over the old method, in going over the freshly-raked surface mixture for the first time. It keeps all oil from reaching the surface, as occurred with the hand roller, and obviates the necessity of having men walk upon the surface before it has been compacted, thus giving a much more uniform consistency to the whole mass."

As a partial or complete substitute for the broken stone, in the present hydraulic base of broken stone, sand and natural hydraulic cement, Capt. Powell thinks it would be desirable to try a "good river gravel," and he asserts that "concrete made of gravel rams much better than that made from broken stone, and can in consequence be made much drier, and is proportionately stronger."

"In the same way as in hydraulic concrete, I would recommend that experiments be made; directed toward determining the possibility of substituting gravel for broken stone in binder. The objection, which has been raised, that such a binder would roll, I do not think can be sustained."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated W=Words.

Gas Supply.

*26667. Gas Purification and Sulphate Producing. W. Belton (C T J–Nov. 3.) 1100 w.

*26694. Combustion Products of Welsbach Burners; Reports of Professor Renk, Dr. Bunte and Dr. Kruger (G W–Nov. 3.) 4500 w.

*26695. Notes on Herr Niemann's Paper on the Strains in Gasholder Guide-Framing. F. S. Cripps (J G L–Oct. 30.) 1500 w.

*26696. Unaccounted for Gas. Lewis T. Wright (J G L–Oct. 30.) 1600 w.

26759. One of the First Meter Makers in the United States. H. C. Slaney (A G L J–Nov. 12.) 3000 w.

26760. Applications of Chemical Technology to Gas Manufacture. George H. Harper (A G L J–Nov. 12.) 7000 w.

*26794. The Merrifield-Westcott-Pearson (Improved Lowe) Carburetted Water-Gas Apparatus, with Editorial. Ill. (J G L–Nov. 6.) 3300 w.

*26795. The Question of Economical Gas En-ichment. Alexander C. Humphreys and A. G. Glasgow (J G L–Nov. 6.) 1000 w.

26806. Patching Holders While in Use. Ill. T. H. Findlay (P A–Nov. 15.) 600 w.

26808. Some Experiences with the Welsbach ncandescent Gas Lamp. W. S. Rathell (P A–Nov. 15.) 2500 w.

26896. Light Wasted in Bad Flames. Ill. N. W. Gifford (A G L J–Nov. 19.) 1200 w.

26897. The Use of Gas for Other Purposes Than Lighting. Burdett Loomis (A G L J–Nov. 19.) 2600 w.

26898. A Small Experimental Plant as an Aid to the Management of a Coal Gas Plant. Peter Young (A G L J–Nov. 19.) 1300 w.

*27064. Notes on Coin Meters. Frank Livesey, with Discussion (J G L–Nov. 13.) 5200 w.

*27065. The Use of Charging and Drawing Machinery in Small and Medium-Sized Gas-Works. Ill. J. T. Lewis, with Discussion (J G L–Nov. 13.) 4000 w.

*27168. The Danger of Modern Gasholder Practice (J G L–Nov. 20.) 2000 w.

*27171. The Gas Industry in the United States. H. Bunte (J G L–Nov. 20.) 2500 w.

*27295. Artificial Illumination in Theory and Practice. Carlton Lambert (P Eng–Nov. 23.) 2200 w.

*27330. A New Motor-Gas Process (I C T–Nov. 23.) 1300 w.

*27350. The Design and Construction of Gas-Works for Hot Climates. Lewis T. Wright (G W–Nov. 24.) 1200 w.

27401. Calculations for the Flow of Compressed Air and Gas in Pipes, Simplified. William Cox (A M–Dec. 6.) 1500 w.

Sewerage.

*26706. Teddington Sewage Disposal Works. Ill. Henry York (Eng L–Nov. 2.) 2000 w.

*26947. Bacteriology of Sewer Air. David Arthur (S R–Nov. 10.) 2000 w.

*26954. The Utilization and Purification of Sewage. Editorial (Eng L–Nov. 9.) 2700 w.

†26955. Teddington Sewage Works. Ill. (Eng L–Nov. 9.) 500 w.

27045. Some Sewer Details. Ill. A. P. Folwell (E R–Nov. 24.) 900 w.

Streets and Pavements.

27044. Australian Hard Wood for Pavements. Walter Alexander Smith (E R–Nov. 24.) 1400 w.

27137. The Park Avenue Improvement in New York. Ill. (Sc A–Dec. 1.) 400 w.

*27310. The Physical Properties of Asphalts. Dolphus Torrey (P–Dec.) 1000 w.

*27311. Road Construction in Vermont. (Extract.) Ill. (P–Dec.) 1800 w.

*27312. Paving Brick: Clays and Methods of Manufacture. W. S. Ravenscroft (P–Dec.) 2600 w.

†27314. On the Technical Analysis of Asphaltum. Laura A. Linton (J A C S–Dec.) 3800 w.

27414. The Organization and Work of a Street Department (E N–Dec. 6.) 2800 w.

*27453. Improved Methods in Laying Asphalt Pavements. Clifford Richardson (P–Dec.) 800 w.

Water Supply.

26676. Water Supply System at Madison Barracks, New York. Ill. (E R–Nov. 10.) 1000 w.

26824. The Manchester Thirlmere Waterworks. Ill. (Sc A S–Nov. 17.) 800 w.

26872. How Much Soil Should Be Stripped from Storage Reservoir Beds? Thomas M. Drown (E N–Nov. 15.) 1100 w.

26900. Removal of Iron in a Ground Water Supply (E R–Nov. 17.) 1400 w.

27022. Water Supply from Saturated Beds of Sand and Gravel (E N–Nov. 22.) 1700 w.

*27169. Sir R. Rawlinson on the London Water Question. (Abstract.) (J G L–Nov. 20.) 1000 w.

†27239. The Color of Water. Desmond Fitz Gerald and William E. Foss (J F I–Dec.) 3000 w.

27415. Experts' Report on the Reservoir Failure at Lancaster, Pa. Henry Leffmann (E N–Dec. 6.) 1500 w.

†27449. Drinking Water in Its Relation to Malarial Diseases. Richard H. Lewis (San–Dec.) 11000 w.

Miscellany.

*26664. Planning the Site for a City. Lewis M. Haupt (E Mag–Jan.) 3000 w.

26677. Water Supply and Sewage Disposal in Some Large European Cities. J. S. Billings (E R–Nov. 10.) 5800 w.

26819. Municipal Electric Lighting. E. Carl Breithaupt (C Eng–Nov.) 3000 w.

*26830. Organization and Management of a City Engineer's Office.—A Symposium. I. Introductory. Albert F. Noyes. II. The City Engineer's Office, Providence, R. I. Otis F. Clapp. III. City Surveys. W. E. McClintock. IV. Survey of the City of Lowell for Assessors' Maps. G. A. Nelson. V. The Relation of the City Engineer to Public Parks. John C. Olmstead. VI. Water Works.—Office Records. Dexter Brackett. VII. Municipal Engineering in Haverhill, Mass. J. T. Desmond (J A E S–Oct.) 32000 w.

26854. Hamburg Disinfecting Establishment. W. H. Robertson (A An–Nov. 15.) 1200 w.

26948. Park Boards and Their Professional Advisers (G & F–Nov. 21.) 1600 w.

27177. The Thackeray Garbage Incinerator for the City of Montreal. Ill. (E N–Nov. 29.) 1600 w.

27178. The Report of the New York Garbage Commission (E N–Nov. 29.) 900 w.

27420. Organization of a City Engineer's Office (E N–Dec. 6.) 2300 w.

27421. Organization and Management of a City Engineer's Office. (Abstracts of papers published in the Journal of the Association of Engineering Societies.) (E N–Dec. 6.) 1800 w.

Serials.

5358. Sewage Purification in America (E N–Began July 14, 1892—43 parts to date—15 cts. each).

14839. Water Purification in America (E N–Began Aug. 3, 1893—15 parts to date—15 cts. each).

23641. Details of Rural Water Supply. Ill. (B–Began July 7—16 parts to date—30 cts. each).

24751. The Gas Manager Abroad (G W–Began Aug. 25—9 parts to date—30 cts. each).

26096. Notes on Modern Gas-Making Plant (I & I–Began Oct. 12—4 parts to date—30 cts. each).

26221. The Manchester Thirlmere Water Works (Eng L–Began Oct. 19—2 parts to date—30 cts. each).

26436. Gas Manufacture. J. J. Johnson (C T J–Began Oct. 27—Ended Nov. 3—2 parts—30 cts. each).

26496. Construction and Working of Regenerator Settings of Retorts. Ill. W. R. Chester (A M & I W–Began Nov. 2—2 parts to date—15 cts. each).

26807. The Gas Industry of To-day (P A–Began Nov. 15—Ended Dec. 1—2 parts—15 cts. each).

26999. Three-Lift Gasholder at the Glasgow Corporation Works (E–Began Nov. 9—Ended Nov. 16—2 parts—30 cts. each).

27075. Wells and Subterranean Water Supply. William D'H. Washington (F W–Began Nov. 24—2 parts to date—15 cts. each).

27272. The Construction of the New Syracuse Water Works. Ill. (E R–Began Dec. 1—1 part to date—30 cts).

RAILROADING

Prevention of Train Robberies—The Caldwell Bill.

A COMMUNICATION from Mr. Charles L. Loop, general auditor Southern Express Company, to the *Railway Age* (Nov. 9) trongly favors the passage of what is known as the Caldwell bill, introduced in he house of representatives Sept. 16, 893. The text of the bill, which it seems night be improved in point of grammatical construction, is given below.

SEC. 1. Be it enacted by the senate and iouse of representatives of the United States of America in congress assembled, hat any person or persons who wilfully and naliciously displaces or removes a railway switch, cross-tie, or rail, or injures a railroad track or bridge, or does or causes to be done an act whereby a locomotive, car, or train of cars, or any matter or thing appertaining thereto, is stopped, obstructed, or injured, with intent to rob or injure the person or property passing over any railroad engaged in insterstate commerce, and in consequence thereof a person is killed, shall be guilty of murder.

SEC. 2. That any person or persons who wilfully and maliciously displaces or removes a railway switch, cross-tie, or rail, or injures a railroad track or railroad bridge, or places an obstruction on such track or bridge, or unlawfully and maliciously displays, hides, or removes a signal or light upon or near to a railroad, or unlawfully and maliciously does or causes to be done anything with intent to rob or to injure a person or property passng over such railroad engaged in intertate commerce, shall, on conviction, be mprisoned at hard labor not less than one or more than twenty years.

SEC. 3. That any person or persons who unlawfully or maliciously throws or auses anything to be thrown, or to fall nto or upon or to strike against a railroad rain, or an engine, tender, car, or truck, ith intent to rob or to injure a person or roperty on such train, engine, car or truck engaged in interstate commerce, shall, upon conviction, be imprisoned at hard labor not less than one year nor more than twenty yesrs.

SEC. 4. That the circuit and district courts of the United States are hereby invested with full and concurrent jurisdiction of all causes or crimes arising under any of the provisions of this act.

In the support of the measure Mr. Loop makes use of the strong argument that the very next step in train-robbing will be the looting of passengers. The suggestions of plans of inventions of burglar-proof cars, of schemes for asphyxiating train robbers, etc., have been as plentiful as the typically numerous car couplers, but any scheme for a traveling fortification is as impracticable as it would be for any person to go habitually clad in armor to prevent assassination or highway robbery. The greatest protection against train robbery must exist in public sentiment, or in fear of the law. That the train robbers do not fear the law is evidenced by their increasing number. That the express companies do take precautions to prevent robbery goes without saying, although their means is not necessarily for publication. It is a matter of fact, in which all express companies will doubtless concur, that the amounts expended in the efforts to detect, apprehend, and convict train robbers far exceed the amount of money actually lost by the robberies."

It is thus seen that the suggestions made in some quarters that the express companies run burglar proof cars, is not regarded as affording a solution of the problem. A reason assigned for the rapid increase of this crime is newspaper exaggeration of the amounts stolen. "For example, the recent robbery of the Adams Express Company on the R. F. & P. R. was heralded all over the country as involving a loss of $180,000, whereas one-tenth of the amount would have been a more accurate statement. Vicious persons, not previously guilty of highway robbery are led by reading these circumstantial accounts of robberies and the extraordinary amounts presumed to have been taken, to consider with what ease and facility they may suddenly enrich themselves."

It is, moreover, urged that "the low rates received by express companies for the transportation of money would not be any compensation for the extraordinary expense that might be necessary to manufacture and haul burglar-proof cars."

The provision in section 4 of the bill, it is stated, has excited "some opposition on account of state rights." It would seem that in a matter of such national importance, such a consideration should be set aside, and that some measure at least as stringent as the proposed bill should be enacted.

The Puzzles of Rate Making.

UNDER this title *The Railroad Gazette* editorially discusses the answer of the Louisville and Nashville road "in the suit of the Cincinnati Freight Bureau to compel the road to reduce rates from Cincinnati to southern cities, as ordered by the Interstate Commerce Commission," and also "the answer of the Northern Pacific and the Great Northern to an order of the railroad commissioners of North Dakota requiring those roads to reduce their rates on coal." Both these documents exemplify the difficulties that beset the subject of "rate-making."

"The points in the argument of counsel are numerous. Lawyers are noted for adducing innumerable reasons why their client should not be made to suffer; but while as a rule nine-tenths of such reasons may be nothing but sawdust, when it comes to freight rate-making, in a country grid-ironed with railroads, this rule does not hold good; there the lawyer who sets out to 'stump' the judge or jury does not have to rake up whimsical arguments, for he has enough good ones. Any one who thinks rate-making is simple work can learn a good deal from the two cases we refer to."

"The pith of the defense" made by counsel for the Louisville and Nashville road is that the commission has made a mistake in adjusting rates over this road from Chicago by those from New York, which have to be reduced to compete with the low water rates southward from New York along the Atlantic Coast.

"It is obvious that no human being is competent to fairly consider all the elements in a comparison of all the claims of Chicago and New York when they are competing for the sale of a box of soap in Alabama." In their answer counsel also allege that "cost per ton-mile is not a just measure of reasonableness of rates" and the commission is regarded as "here again treading on insecure ground."

"The average cost per ton is so affected by the kind of freight that a road hauls most of, that this argument is probably no whit better than to take the granger's original and all-embracing claim: 'you are making too much money and we propose to have make you make less.'"

It is finally alleged that "in naming rates to a number of cities and requiring the road to go on and follow out the same rule in making tariffs for other cities not named, the commission asks an impossibility." This claim of counsel, is viewed as technical only, as it is thought that if the road in question made in good faith an effort to carry out the requirements, the commission would be satisfied with their best efforts, not exacting what can clearly be shown to be an impossibility.

Sharp Flanges.

"A SHARP flange," says the *Street Railway Journal* for December, "may be technically defined as one in which the part o the flange next the rail has become vertical. The extent of this vertical surface o its depth may be said to determine the degree of sharpness which does not, as migh be supposed, necessitate a razor edge upo the flange. Another definition of a shar flange would be a wheel in which the flang is so worn as to be without flare. A shar flange mounts the rail with extreme eas regardless of the actual depth of the flang itself, and hence is always likely to produc a derailment from the most trifling caus

The reason for this is not at once evident. With a vertical side the five-eighths flange of an ordinary thirty-inch wheel will touch the rail for four and a half inches in advance of the point of contact between wheel tread and the rail. The whole of this surface is an actual grinding contact with a rail of ordinary section. The result is a powerful lifting action, greatly aggravated by any side motion, by dirt or other obstruction. In this way, the forward revolution of the wheel is constantly tending to throw the car from the track. A very similar case, which all who are familiar with steam-engines will call to mind, illustrates the point; it is the ease with which a governor belt jumps off from the double flanged pulleys on which it runs. These pulleys have vertical flanges, often of considerable depth." This state of a wheel, which is considered as very dangerous, is illustrated in the diagram reproduced from the journal quoted, which also asserts that no other defect is more likely to produce accidents.

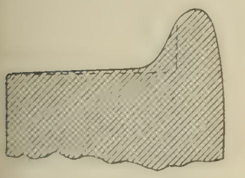


FIG. 1.—OUTLINE OF FULL AND OF SHARP FLANGES

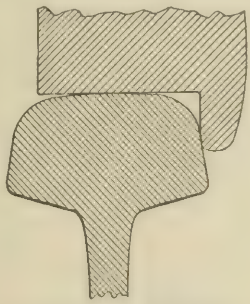


FIG. 2.—SHARP FLANGE ON IMPROVED RAIL SECTION.

One cause early assigned for this defect, was that the two wheels being put on the axle without regard to their roundness or equality of size just as they came from the foundry, and one being softer than the other, the soft wheel in some way or other acquired the shape indicated. Difference in diameter would tend to cause "one wheel to run forward," and thus "force the opposite wheel against the rail." But in modern practice great care is taken to size the wheels accurately and hence this cause can no longer be considered valid. "The diameters of two wheels on the same axle are practically obtained to within the hirtieth of an inch.

"'Trucks out of square,' or a want of parellelism between the two axles of a truck, is now considered one of the most frequent causes for sharp flanges. At least, recent experiments point to this as the case. If squaring gages are not carefully used, this is often an unexpected cause. Even by the employment of gages it is not always easy to determine the absolute parallelism of the axles, nor can it always be established that they are also at right angles to the rails. It may also happen that, while the axles are at right angles to the track, and parallel to each other, the wheels do not 'track' properly. In other words, while the axles form with the side bars of the truck the four sides of a parallelogram, it is not rectangular. In such cases the diagonal distances from tread to tread will not be equal. In trucks without attached bodies, gages from center to center of brasses can be used for the purpose of testing this point.

"Trucks that start square in the world not infrequently become distorted by severe usage, in accidents, etc. On steam roads such distortion was not uncommon. But as the gaging was by no means as difficult as on the street railways, there was little excuse for such a condition. On street cars, the difficulty of tracing this want of parallelism in the axles becomes very great, and much of the trouble of sharp flanges undoubtedly might be avoided could this one cause be more carefully controlled."

However, if a remedy can be found it is not worth while to speculate at length upon the occult causes of the defect, although remedies, when their action is well understood, ought to suggest causes, and this appears to have been the result. The chief cause is now considered to lie in a faulty shape of the head of the rail. The wheel tends to assume a form according with that of the rail. "Some years ago, several steam roads in this country, in investigating this subject, came to the conclusion that if the corner of the rail was not sharp enough to cut a groove in the wheel, sharp flanges would not result. In other words, they believed that the wheel wearing against the rail finally took the form of the rail head. Acting upon this, a rail head was designed, which should more nearly fit the ordinary form of wheel when new. An outline of this head is shown in Figure 2. The dotted outline shows how the sharp flanged wheel, in Figure 1, would ride upon such a rail, and it also clearly proves that such a rail is incapable of wearing a wheel into any such form as that shown in the first figure. In a word, the theory was that though there might be numberless reasons to determine the cutting, yet if the cutting member is so shaped or formed as to make an effectual barrier against the production of the undesirable form of wheel, the trouble will be avoided, and sharp flanges become a thing of the past. Several roads adopted the form of rails shown, and with the most satisfactory results."

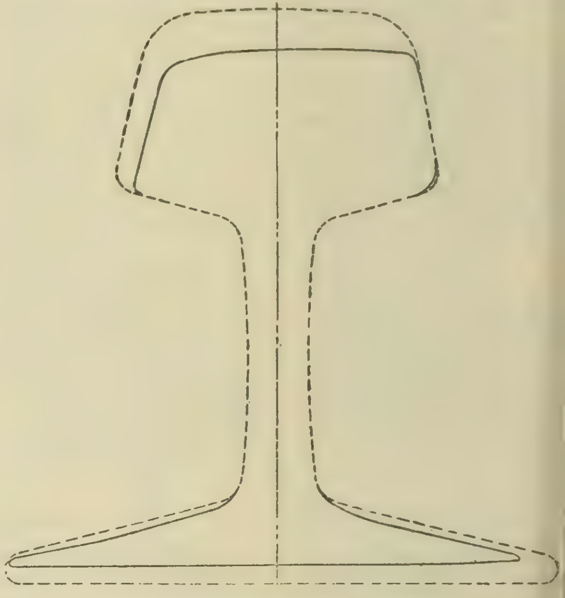
Subsequent investigation has proved the soundness of this view, and the adequacy of the remedy applied. It may be laid down as a principle in mechanics, that where mutual wear takes place between the surfaces, that which under the existing conditions must wear the more rapidly will gradually approximate in form to that which wears least. In this principle is not only indicated the cause but the remedy for sharp flanges.

Corrosion of Rails in Tunnels.

A REMARKABLE example of corrosion of a rail in Musconetcong tunnel on the Lehigh Valley railroad, is illustrated in the accompanying diagram which accompanied a description of the same in the *Railroad Gazette* (Nov. 23). It is almost incredible that all this damage should have resulted in the time the rail was in the tunnel, but facts are stubborn things. "The section shown in dotted lines is the original from the rail; the full lines show the loss of material by corrosion." It was originally a 76-pound steel rail. The diagram is to a scale $\frac{1}{2}'' = 1''$.

"The rail had been in the track five years. It will be observed that much the greatest loss by corrosion is in the bottom flanges, the loss from the top and running side of the head is of course from wear. It seems a curious circumstance that the loss was so largely from the under side of the flange. There is little diminution of the thickness of the web, and the under side of the head seems to have lost very little.

"From E. J. Dorsey, supervisor, we have ascertained that there can be no question about the two sections having originally been alike. The worn section was cut from a rail where it rested on a tin plate, but the same results are shown where the rail was on the tie itself. The roadbed is practically solid rock bottom, and it is impossible to change the surface on account of the limited space. The track has therefore little or no elasticity. The tunnel is very wet and the rails slippery and a good deal of sand must be used. This collects along the rail and works underneath the base, adding no doubt, to the wear by friction between the rail and the tie or tie plate. This influence, acting with the corrosion caused by the gases, wears the rails out very fast."



CORROSION OF RAILS IN TUNNELS.

Is it not possible that, issuing from th rock in the tunnel there may be some ga of an acid character that has aided in th rapid destruction of the rail? If ther is so much drip in the tunnel, the wate absorbing such a gas would become very active reagent. Is it not also possible that as a part of the rail rests on tin plate a certain amount of galvanic action is set up throughout the entire lengt of the rail? Such action, if set up, woul not be likely to be confined to the near v cinity of the tin plate.

Car Lighting.

THE subject of car lighting with reference to its influence upon the passenger traffic of competing roads, and as related to the comfort of travelers who patronize railways, is well discussed by a correspondent of *The Railway Review.* The traveling public demand some better and safer method of car-lighting than kerosene lamps. It is urged that "the day has gone by when passengers will longer be satisfied to make long or short after-dark journeys in poorly lighted cars. The long dissatisfaction on this score has been much enhanced by the fact that one-sixth of the passenger, mail and sleeping cars now running on American roads are lighted by Pintsch gas, and most people who travel have made a few journeys in cars thus lighted, and they have thus learned that cars can be well and safely lighted. This has made them less patient with the ancient kerosene contrivances which still prevail on many roads, and as a consequence the roads running the best lighted cars get most of the after-dark travel. This was demonstrated on the Broadway and the Third avenue roads of New York when they put in Pintsch lights. Three lamps to a car were used, with four burners to a lamp. The resulting growth of traffic was both rapid and permanent; thousands of people who had previously ridden in the kerosene lighted cars of the Manhattan elevated railway, immediately changed to the well lighted cable cars, where their eyes were not strained to read their papers."

The writer of this protest claims to have been a considerable night traveler by rail and also a very considerable reader, and he speaks from experience of the great annoyance that attends the use of badly trimmed, frequently smoking, and always foul-smelling kerosene lamps with which the majority of cars are lighted. As to electricity, it is doubtful that it will ever be extensively used for car-lighting except on electrically operated railways, and hence gas, which has long been proved the best car illuminant yet discovered will doubtless ultimately become the chief resort for this purpose. The danger in the use of kerosene as a source of fire in wrecked trains is pointed out, although this seems much less than that attending the use of stoves, which has been largely abandoned. To substantiate the claim of danger in the use of kerosene lamps, a number of cases of destruction by fire of mail cars alleged to have been thus caused are cited.

Strategic Mountain Railways.

THE term "strategic" has been applied to railways which were not wholly designed for military purposes in time of need, being used for ordinary traffic in time of peace, but which are, however, specially located and adapted for military service in time of war. Among the more remarkable of these are such as are specially intended to facilitate mobilization of troops over mountain ranges. An enumeration of the latter, and a description of their leading features form the subject of a serial begun in *Engineering* (London, Nov. 2), and written by C. S. Du Riche Preller, who has recently inspected some of the more important examples of railways with steep inclines.

In the category of "strategic mountain railways," are not included such lines as the Mont Cenis, St. Gothard, Arlberg, Brenner and Semmering, though in time of war these would be important lines of military communication; they are properly to be considered as great international highways, and as such form a category apart.

"On the other hand, some of the mountain trunk railways of Switzerland, no less than a similar line recently opened in Japan, may fairly be included, for although not, perhaps, of immediate or paramount strategic interest, they yet form important links in the defensive communications of these two countries, while, in time of peace, they serve, in common with the other lines, the purposes of ordinary traffic. The railways to be briefly considered are therefore, those of Usui Pass in Japan, the Black Forest, the Höll Valley, and the Waldshut and Impendingen (Buchberg Pass) in the Grand Duchy of Baden, South Germany; the South-Eastern (Altmatt Pass) in Switzerland, and the Sarajevo and Konjica line (Ivan Pass) in Bosnia and Herzegovina."

Particulars of the Usui Pass railway in Japan, opened last year, are at present of much interest, as the attention of the world is now centered on that remarkable country.

"The line is on the 3.5-foot gage, and the incline is laid with treble 20 millimeter, Abt, rack, steel bars. As Mr. Pownall rightly observes, the incline is essentially what Mark Twain would call 'a railway decorated with tunnels,' there being in the total length of five miles no less than 26 tunnels, of an aggregate length of 2.6 miles. It might be added that it is also a railway 'decorated with bridges,' for of these there are no less than 34 in number. The total rise is 1573 feet and the gradient is nearly uniform, viz., 1 in 15, or 6.66 per cent., while the curvature is comparatively easy, the minimum radius being 13 chains. The permanent way, laid with steel sleepers, is of a very substantial character. The whole line is worked with Abt adhesion and rack or so-called 'combination' engines, built at the locomotive works of Kessler & Co., Essligen, Wurtemberg. The first engines sent out, of about 36 tons (10 tons tractive power and 260 horse-power), are now being replaced by a more powerful type of 50 tons, capable of hauling, under the indifferent conditions of adhesion in the tunnels, a load of 100 tons at five miles per hour."

In South Germany, of the mountain lines classed above as strategic, the Waldshut and Impendigen railway is regarded as a typical railway of this kind, although descriptions of the others are given. It is the most costly of all the German railways, "a strategic mountain railway in the strict sense of the term, with long sidings at every station for military trains. . . The stipulated gradient of one per cent. on the mountain section, viz., on the divide of the Rhine and Danube watersheds formed by the Buchberg necessitated an extensive development of the line by means of an extraordinary series of serpentines and helicoidal or spiral tunnels . . . which render the line one of the most remarkable of its kind." There are six of these tunnels aggregating three miles in length, and four viaducts, all in a distance of sixteen miles. The total cost of the line (47 miles) is stated to have been $4,356,000.

Railroad Cars and Practice in England.

RETURNING from a trip in "the old country" to the United States, Mr. Edward Webb, foreman of one of the departments of the Laconia Car Company thinks his impressions of English cars, and of English railway practice in general, may prove of interest to American readers. Accordingly, in the *Railroad Car Journal* for November, he prefaces an account of what he recently saw with a statement that he left England when a young man (1859), and then makes a comparison between the status of things in railway practice as it was more than thirty years ago, with what is now in vogue.

Admitting that he sees things differently after thirty years' familiarity with railway appliances than when in adolescence he left England and came to the United States, he says the railway cars of to-day look to him very much as they did at the former date, and that though they must, in the nature of things, have shared somewhat in the general onward progress, "an English car is an English car, and you cannot look at it in any other light," and that "no American traveler in England can fail to notice the difference between English and American cars.

"The baggage arrangements would drive an American nearly crazy. A first-class passenger is allowed 120 pounds, third class, 60 pounds. He has to look after it himself, no checks being given; so if you are going a long journey and have to make three changes of trains, which is not impossible, you have the pleasure of three times going up to the baggage car at the station where you 'change' and hunt for your baggage. If baggage is left at the station it must be booked and paid for at the rate of four cents on each piece. This secures it for 48 hours; after that time there is a storage charge of two cents each day for each piece. The company is only responsible for 'booked' baggage.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

25956. Street Railway Repairs. J. B. Cahoon (E W–Oct. 20.) 5000 w.

26402. The Puzzles of Rate-Making. Editorial (R G–Nov. 2.) 1800 w.

*26666. Half yearly Meeting of the Grand Trunk Railway of Canada. Address of President Henry W. Tyler, with Discussion and Editorial (Ry T–Nov. 3.) 7000 w.

26669. Cost of Power in Car Shops. James F. Hobart (R C J–Nov.) 600 w.

26671. Railroad Cars and Railroad Practice in England. Edward Webb (R C J–Nov.) 1200 w.

26672. Car Cleaning. Report of Committee, with Discussion (R C J–Nov.) 1600 w.

*26680. The Railway Year in Queensland (Tr–Nov. 2.) 1800 w.

*26686. Report of the Special Committee on Light Railways for Agricultural Purposes (I C T–Nov. 2.) 5000 w.

*26702. Express Passenger Locomotives, Great Western Railway. Ill. (Eng L–Nov. 2.) 1000 w.

*26707. The Board of Trade and Light Railways. Editorial (Eng L–Nov. 2.) 1700 w.

*26713. The Board of Trade and Light Railways. Editorial (E–Nov. 2.) 3000 w.

*26716. The Alleged Lock and Block Failure at Baker Street Station. Ill. (E–Nov. 2.) 1800 w.

26730. Storage Battery Traction. Pedro G. Salom (S R G–Nov. 10.) 1000 w.

26731. Interference with Street Railway Traffic. R. D. Fisher (S R G–Nov. 10.) 1500 w.

*26737. The St. Gothard Railway. Ill. (R W–Nov.) 2000 w.

*26738. Some Railway and Tramway Exhibits at the Antwerp Exhibition. Ill. H. Conradi (R W–Nov.) 2600 w.

*26740. The Northallerton Accident and Its Lesson. Ill. (R W–Nov.) 800 w.

*26747. Electric Fog-Signalling on Railways (E L–Nov. 2.) 1000 w.

26766. Prevention of Train Robberies—The Caldwell Bill. Charles L. Loop (R A–Nov. 9.) 900 w.

26784. Car Lighting. W. A. T. (R R–Nov. 10.) 800 w.

26785. Live Stock Rates. Editorial (R R–Nov. 10.) 1000 w.

26786. Heating of Large Railway Buildings. Editorial. (R R–Nov. 10) 900 w.

26788. Cinder Pits.—Report of Committee. Presented by W. G. Berg, Chairman (R R—Nov. 10) 3000 w.

26793. Is There a Solution of the Electric Conduit Railway Problem? (Abstract.) Joseph Sachs (E R N Y–Nov. 14.) 3000 w.

*26813. Train Lighting by Electricity on the Danish State Railways (M W–Nov. 9.) 600 w.

26817. Railway Building Across Peat Bogs (C Eng–Nov.) 900 w.

*26832. Road Test of a Modern Ten-Wheel Freight and Passenger Locomotive. W. G. Kranz and J. B. Turner (S J E–Oct.) 1000 w.

26867. The Value of Branch Lines of Railway (E N–Nov. 15.) 800 w.

26870. How the New York Rapid Transit Railway Will Be Built (E N–Nov. 15.) 1600 w.

26874. Draft Rigging Between Floor Sills of Freight Cars. Ill. (R G–Nov. 16.) 1500 w.

26875. The Economical Load for Locomotives. Charles Paine (R G–Nov. 16.) 600 w.

26876. State Railroad Control in Texas. Editorial (R G–Nov. 16.) 1800 w.

*26878. Construction and Operation of Small Street Railways. W. Worth Bean (S R R–Nov.) 1200 w.

*26879. A Comparison of Rheostat and Series—Parallel Control (S R R–Nov.) 400 w.

*26881. The Evolution of Electric Traction. William Clinton Burling (S R R–Nov.) 2800 w.

*26883. New Plant of the Chicago General Railway. Ill. (S R R–Nov.) 900 w.

26903. East Boston Electric Railway Power Station (E R–Nov. 17.) 1600 w.

26931. Areas of Contact between Wheels and Rails. Ill. (R R–Nov. 17.) 700 w.

26933. Economies in the Telegraph Departments of Railways. Editorial (R R–Nov. 17.) 1000 w.

*26946. Light Railway Development (I & S–Nov. 10.) 4500 w.

*26953. English and American Locomotives in the Argentine Republic. Editorial (Eng L–Nov. 9.) 2000 w.

27005. The Electric Railway System of Toronto, Canada. Ill. (E E N Y–Nov. 21.) 1800 w.

27031. Improvement of Block Working. C. C. Anthony (R G–Nov. 23.) 1200 w.

27033. Hydraulic Tools and Plant in French Car Shops. Ill. (R G–Nov. 23.) 1400 w.

27034. The Economics of Lubrication. Editorial (R G–Nov. 23.) 1000 w.

27035. The Elevated Railroads in New York. Editorial (R G–Nov. 23.) 1000 w.

*27042. Light Railways for Farmers. Editorial (Eng L–Nov. 16.) 1800 w.

27076. The Ridgewood Power Station, Brooklyn. Ill. (S R G–Nov. 24.) 1000 w.

*27077. Light Railway Problems. Editorial (Ry T–Nov. 17.) 1000 w.

*27090. Electric Traction on Street Tramways. Editorial (E–Nov. 16.) 2200 w.

*27092. The International Railway Congress (E–Nov. 16.) 1300 w.

*27125. The Progress of Electric Traction in Germany (E R L–Nov. 16.) 800 w.

†27153. Notes on Unit Stresses for Railroad Bridges of Wrought Iron. Silas G. Comfort, with Discussion (P E C P–Nov.) 4000 w.

27158. History of Freight and Passenger Terminals at St. Louis (R G–Nov. 30.) 2200 w.

27159. A Bridge Built of Old Rails. Ill. (R G–Nov. 30.) 800 w.

27161. English Signal Practice. F. A. Delano, with Editorial (R G–Nov. 30.) 7000 w.

27162. The Elevated Railroad Loop Situation in Chicago. Editorial (R G–Nov. 30.) 1800 w.

27175. Shall Freight be Handled on the New York Rapid Transit Railway? (E N–Nov. 29.) 2000 w.

27176. Power House and Electric Locomotives for the Baltimore Belt Railway. Ill. (E N–Nov. 29.) 2000 w.

27179. The Webber Combined Brake and Fender for Street Cars. Ill. (E N–Nov. 29.) 900 w.

27207. Notes on Economy Tests of Electric Railway Plants. George H. Davis (E W–Dec. 1.) 2500 w.

27208. The Sag in Span and Trolley Wires. E. A. Merrill (E W–Dec. 1.) 1000 w.

†27215. Brigandage on Our Railroads. Wade Hampton (N A R–Dec.) 1500 w.

†27227. Present and Prospective Development of Electric Tramways. C. J. Field (A S M E–Dec.) 5200 w.

†27237. Strength of Railway Car-Axles. L. S. Randolph (A S M E–Dec.) 1200 w.

27254. Lenox Avenue Conduit Construction, New York. Ill. (S R G–Dec. 1.) 600 w.

27255. Franchises. R. D. Fisher (S R G–Dec. 1.) 2000 w.

*27268. The Great Northern Railway Company's Goods Depot, Farringdon Road. Ill. (Eng L–Nov. 23.) 3500 w.

*27281. Going Through Normandy. Ill. A. S. (L E–Dec.) 3300 w.

*27282. Block Signaling on the New York Central Railroad. D. B. McCoy (L E–Dec.) 1700 w.

*27284. The Past and Present of Car Ventilation (L E–Dec.) 1100 w.

*27285. How Rail Joints May be Made. Ill. Joseph Anthony (L E–Dec.) 1400 w.

*27287. Cleaning of Passenger Cars (L E–Dec.) 600 w.

*27337. Electrical Steep-Grade Traction in Europe. C. S. Du Riche Preller, with Discussion (E E L–Nov. 23.) 4800 w.

*27338. Notes on the Different Kinds of Processes Used on the European Continent for Preventing Incrustations in Locomotive Boilers (N C B–Dec.) 1000 w.

*27339. Railway Coach Varnishing. J. H. Pitard (N C B–Dec.) 1200 w.

*27340. Some Economical Characteristics of Locomotive Injectors. Strickland L. Kneass (N C B-Dec.) 1500 w.

*27363. The Light Railway Question (Tr–Nov. 23.) 2000 w.

*27364. State Subsidies to Light Railways (Tr–Nov. 23.) 2300 w.

†27383. The Street Railways of Washington, D. C. Ill. (S R J–Dec.) 5800 w.

†27384. The Wyoming Valley Interurban Railway. Ill. (S R J–Dec.) 3000 w.

†27385. Some Details of the Electrical Railway Work of the New Orleans Traction Company. Ill. W. Nelson Smith (S R J–Dec.) 1700 w.

†27386. Underground Electric Railways in London. Alex. McCallum (S R J–Dec.) 2200 w.

†27387. Sharp Flanges (S R J–Dec.) 2300 w.

†27388. Motor Repairs. Ill. James F. Hobart (S R J–Dec.) 1400 w.

†27389. Notes on Power Station Economy. George H. Davis (S R J–Dec.) 1800 w.

†27408. Rubber as a Factor in Safety on Railways (I R W–Dec. 10.) 1000 w.

27426. Some Lessons of the Scrap Pile. (Synopsis.) J. N. Barr (R G–Dec. 7.) 1600 w.

27427. The M. C. B. Coupler in 1894.—Discussion of Paper by A. M. Waitt (R G–Dec. 7.) 4000 w.

27428. The Proposed M. C. B. Coupler Tests. Editorial (R G–Dec. 7.) 1600 w.

Serials.

22639. A Master Car Builder's Reminiscences. John Kirby (R C J–Began June—4 parts to date—15 cts. each).

24586. Railway Companies and Their Employés. Ossian D. Ashley (R A–Began Aug. 24—5 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R–Began Aug. 25—14 parts to date—15 cts. each).

25348. Mechanical Traction for Tramways (E E L–Began Sept. 14—Ended Nov. 16—5 parts—30 cts. each).

25599. Notes on the Management of Railway Power Stations. George T. Hanchett (E W–Began Oct. 6—9 parts to date—15 cts. each).

26554. The General Theory of Rates. Charles H. Cooley (R R–Began Nov. 3—Ended Nov. 10—2 parts—15 cts each).

25954. Electric System of the Philadelphia Traction Company. Ill. Hermann S. Hering (E W–Began Oct. 20—Ended Nov. 10—4 parts—15 cts. each).

26525. The Liverpool Overhead Railway (E R L–Began Oct. 26—Ended Nov. 2—2 parts—30 cts. each).

26711. On Strategic Mountain Railways. Ill. C. S. Du Riche Preller (E–Began Nov. 2—Ended Nov. 23—3 parts—30 cts. each).

26989. Electric Traction, with Special Reference to the Installation of Elevated Conductors. Robert W. Blackwell and Philip Dawson (El–Began Nov. 9—2 parts to date—30 cts. each).

27091. The Manchester and Sheffield Railway Extension to London. Ill. (E–Began Nov. 16—1 part to date—30 cts).

SCIENTIFIC MISCELLANY

Suggestions for an Index for Technical Literature.

THE pressing need for an index of the kind named in the title, a brief history of the attempts made to supply it (most of which have failed to give what the public wants, while a number have been discontinued for want of financial support), and suggestions for an index that shall "avoid the failings of those already existent," are topics treated in a paper by Prof. George D. Shepardson in the *Transactions of the American Institute of Electrical Engineers* for November. The paper demonstrates that while it is not very difficult for any man to state his particular idea of what an index of technical literature ought to be, it has not been an easy matter to supply just what is wanted by the public. No one has yet been found to publish such an index solely out of a desire to benefit technical students and readers, and no one, until this magazine evolved it, has been able to produce such an one as would draw to it a substantial financial support. As well known, we began this index tentatively, and by feeling the public pulse, so to speak, we have been able to gage our progress toward that form which on the whole, as the demand for it compels us to believe, meets with wider approbation than any other. This effort has involved an amount of labor, to say nothing of expense, which few would be prepared to appreciate. The following are some of the attempts that have been made in this line as named by Prof. Shepardson.

"Perhaps the greatest of these is the 'Royal Society Catalogue of Scientific Papers,' consisting of eight quarto volumes of about 1000 pages each. This was compiled under the auspices of the Royal Society of England, and was printed by the English government at public expense. It gives alphabetical lists of titles and authors of scientific papers published in every civilized country, between the years 1800 and 1873, but exclusive of technical and professional papers." Prof. Shepardson thinks next to this stands Poole's Index of Current Literature, published in this country by private enterprise. The first volume, compiled with the coöperation of 52 libraries, indexed 6200 volumes which were published during the period from 1803 to 1882 and contains about 1000 references to articles on electrical subjects that appeared in popular and scientific journals. The second volume, to which 97 libraries contributed, covers the period from 1882 to 1887, and contains about 600 references to articles on electrical subjects. The third volume, compiled with the coöperation of 122 libraries, covers the period from 1887 to 1892, and gives about 500 references to electrical papers. The volume for 1893 gives about 100 such references. In Poole's Index there is some attempt at classification of electrical papers and there are a few cross references.

"The Descriptive Index of Current Engineering Literature, compiled from the monthly summaries in the Journal of the Association of Engineering Societies, gives an excellent résumé of engineering literature between 1884 and 1891. This is devoted principally to civil engineering, but gives about 30 pages with 700 references to electrical papers. Most of the references indicate the character of the papers. The cross references are excellent. The index in the Journal of the Association of Engineering Societies is commendable in that it prints the indices on only one side of the leaf, so that they may be cut and rearranged according to the ideas of the individual. The Journal for each December contains a summary of the monthly indices of the year.

"The American Institute of Electrical Engineers published in its Transactions for about three years, 1886 to 1888, an excellent index of current electrical literature compiled gratuitously by a gentleman too modest to have his name appear. Volume v of the Transactions contains about

5100 references, volume vi about 5800, and the first numbers of volume vii contain about 1500 references. Some of these are accompanied by descriptive notes.

"The first volume of Galloupe's *Engineering Index*, compiled and published by private enterprise, gives about 28 pages with 1500 references to articles on electrical subjects appearing in the years 1883 to 1887. The second volume, 1888 to 1892, gives 61 pages with about 3300 references, titles and authors being given.

"Excellent indexes have appeared in THE ENGINEERING MAGAZINE and in *Electrical Engineering*, the figures for which are not at hand. Recently *Electric Power* has launched out into this field. The digest of foreign literature in the *Electrical World* is commendable, but confessedly incomplete. Extended indexes are published at intervals by the French and Germans. A universal index, published weekly at Leipzig, aims to give tables of contents of a number of journals arranged in the alphabetical order of their places of publication. Doubtless there are other indices not known to the present writer.

"To the mind of the writer, the most ideal index yet attempted was that published at first in connection with *Electrical Engineering* and later as a too short-lived publication by itself under the name of *Electrical Literature*. The printing of the indexes on separate sheets, perforated and tied together, each sheet being devoted to a single subject, combines the advantage of flexible classification of subjects with ease of arranging the sheets from month to month so as to make the bibliography of each subject consecutive and up to date. Having the sheets loose and perforated for binding with brass clips or cords, allows each individual to supplement the printed sheet by his own notes or additional references. The publisher is also able to add sheets descriptive of later or earlier memoirs without impairing the integrity of previous work. It should be and doubtless is a matter of sincere regret by the electrical and mechanical engineering profession that this publication was forced to suspend on account of lack of financial support.

"Another valuable, but less extensive index was published in the *Electrical World*, vol. xii, p. 6, July 1, 1893, by J. Stanford Brown, giving about 375 references to papers on 'Accumulators in Practical Work.'"

It is evident that the chief obstacles to continued and systematic indexing of technical literature have proved to be insurmountable on any of the lines of which details are above given. Some included too little, others too much. Financial support was lacking undoubtedly because that which was desired in common by a sufficient number was not furnished. That THE ENGINEERING MAGAZINE has been more fortunate in its attempt to do this than others, is due to the fact that a scheme with hard and fast lines was not planned in the outset, but that the present method has been slowly evolved, and its scope extended to meet the ascertained wants of those who patronize it. Not that it has been, or ever will be, possible to suit every one; to attempt this would be even more impracticable than the adoption of a rigid scheme in advance of the knowledge of what is most wanted. But the effort to find out what is wanted by the large majority of readers and to meet this want as nearly as possible, has resulted in the present form of indexing titles, which together with the facilities afforded for obtaining the indexed articles has succeeded beyond the most sanguine expectations. Prof. Shepardson outlines the requirements for a technical index such as would meet his views, as follows:

"It should include subjects relating to electrical, mechanical, hydraulic and civil, and perhaps mining engineering, It should index books as well as periodicals. The references should be descriptive so far as practicable. Each subject should have a page by itself. Digests and simple references might be on separate sheets. References and sheets on some subjects might be numbered consecutively for convenience in adding later notes from other files or from later publications of the same articles. Abbreviations or other symbols should indicate whether the reference is to the original paper or to re-print, whether the paper is in full or abstract, whether accompanied by discussion and by plates or illustrations. The separate sheets should be perforated for re-arranging and rebinding and should be printed on one side only. It might be preferable to print the whole index of cards similar to those used in the card catalogues of libraries.

"In this way it would be practicable to begin publication at an early date and to issue parts at frequent intervals. The indexes to current publications could be issued without delay, and those of completed files or historical works could appear as the work proceeded. Publishing the work in sections would allow each engineer or student to purchase or subscribe for only such subjects as were of importance or interest to him. Indeed the work, if carried out properly, would result in so massive a catalogue that few outside of libraries or other public institutions could afford to obtain the entire work."

It is frankly admitted that such an index as will be an improvement over existing ones can only be produced by "the coöperation of a large number of people, as was Poole's index to which over 122 libraries contributed," and "that it will require the expenditure of a considerable amount of money, and will probably not be self supporting." Unless some public benefactor shall arise who would be willing to provide a permanent fund to supply deficiencies, the scheme therefore seems visionary and impracticable.

Mental Training—A Remedy for Education.

THIS title indicates something startling. Is education really injurious, that a remedy needs to be supplied for it? William George Jordan, in *The New Science Review*, speaking of "education as we know it to-day," expresses this view. It can scarcely be said to be original with him, since others have not only thought, but publicly expressed the same opinion. The modern system of cram, produces a sort of mental fatness, as the forced feeding of geese fits their livers for the manufacture of pies. Mental alertness, agility, precision, which should result from proper mental training, are replaced by dull perception, sluggishness, inaccuracy.

"There are two things that education should do for the individual—it should train his senses and teach him to think. Education as we know to-day, does not do either; it gives the individual only a vast accumulation of facts, unclassified, undigested, and seen in no true relations. Like seeds kept in a box, they may be retained, but they do not grow. For years the mind is filled with facts that the mind is not trained to digest. To the physical body food is of value only when digested; so it is in the mind with mental food; but if digestion were made continuous, perfect, and ever equal to the supply of food, overfeeding, either in mind or body, would be impossible. But in the education of to-day the digestion is not equal to the feeding."

This is a grave charge, not made as "a criticism of the splendid work of individual teachers, professors, and other educators who have been successful," but directed against the system of modern education. Whatever success these eminent instructors may have had "has been in revolt against conventional machine methods." The object of teaching should be to "quicken, intensify, and develop the working of the mind." It should "train every sense, every faculty, every memory, every power, part and phase of mind, every mental muscle, making it supple and instantly responsive."

This obviously implies that the use of the mind is not analogous to that of a great warehouse, though even in warehouses there is usually some order in the way things are put away, so that they can readily be found when wanted. The mind should be active. It should be as ready to give as to take. Mere passive receptivity never yet was characteristic of mental power.

"With most persons the intellectual brilliancy, the proper thing to say, comes as an afterthought. An afterthought is but a beautiful possibility designed to fit a lost opportunity. It is no more helpful to a man than a flattering epitaph on his tombstone. With most persons this wit is like a night telegram,—it is not delivered until the next morning. Man expects his hand to be instantly ready to perform any motion of which it is capable; but he is resigned if his mind does not work quickly. He says that readiness is born with people; it cannot be acquired. If a man's heart, lungs, or stomach are weak, he consults specialists, and never gives up until he obtains relief. But if he cannot remember names or faces; if he is subject to that intellectual remorse known as afterthought; if he has no eye for color, or taste for music; if he has no command of language; if there is lack of power in any respect in his mind, he is perfectly resigned, and says, 'I am as God made me, and so I must remain.' When man fails he always does this. He says, 'I am as God made me'; but when he succeeds, he proudly proclaims himself a 'self-made man.'"

The faculties of the mind are "impression, repression, and expression," which is only claimed to be a sort of a rough classification. The first of these categories includes the senses, through which perceptions of external things reach the mind. Repression is used as a synonym for memory "which by cerebration analyzes all this raw material, combines, recombines, deepens and classifies it ready for expression. . . . Expression uses the material the senses have received and memory has classified,—in writing, speaking, clear formulation in words, drawing, or some other form of outward activity." The impressions received in modern schools are compared to geological strata, lying upon and concealing each other.

"Does not all the inability of an ordinary college graduate lie in matter of expression? Is his mind quick to analyze a new subject and to see it in its new relations? To ask a good question? To give a quick illustration? To make a fair description? To be ready in conversation? To sum up, to epitomize, to formulate his own views? To make a generalization? He has information, but so has a library; he has a vocabulary, but so has a dictionary. To be of service to him in the battle of life his information and his vocabulary must be held in immediate readiness. Mental training recognizes these three divisions; gives each careful exercises to keep each in its best condition as a part of the instrument, and then trains the mind to pass every impression through the trifold process—a training that soon results in automatic action.

"One illustration out of a number showing deficiencies in training the senses, is that 'men fail in spelling, hopelessly surrendering to the belief that they can never learn to spell, because the power of visualizing words has never been developed.' Pronunciation of words is hardly ever entirely correct because the sense of hearing has not been trained to detect nice distinctions between different sounds. Defects in penmanship result from lack of suitable muscular training, and the training of the eye to detect differences in form. That with any one sense weak, our impression of the whole is weakened in proportion" is a most important proposition. An illusion is not a failure of one or two senses only to derive correct impressions of external objects, it involves the deception of all, or at least so many that wrong impressions preponderate, and right impressions are too feeble to correct the erroneous ones.

"Constant training in words is a vital part of mental training. When the powers of expression are strengthened and exercised, they react upon the faculties of impression. The more clearly we can express ideas, the more accurately and readily can we receive them. This one great need in education to-day is passed by with a trivial recognition that is a disgrace to education." The rigidity of systems in modern public schools is denounced. Both teachers and pupils work in one groove constructed by some superintendent, who fancies his ideas are original and superior to all others, and whose methods, nine times out of ten, are reflections of his own defective training. This has the effect of suppressing all originality on the part of the teachers employed, and native genius for teaching is thus cramped. Another mind is interposed between that of the pupil and his instructor, which like an impenetrable screen prevents direct and close contact.

Prof. Dewar's Latest Experiments.

In the *New Science Review*, an able quarterly recently started in New York, the second number of which is rich with the newest discoveries in science, and with discussions of scientific topics now taking front rank in importance, the first of the leading articles is by Prof. James Dewar who has won a world-wide fame by his brilliant experiments in the liquefaction and solidification of gases through the influence of extremely low temperatures. From time to time the results of these experiments have been noted and their possibilities have been pointed out in these departments. Some results not anticipated have, however, been reached, and it is with unexpected phenomena of fluorescence or phosphorescence, that Prof. Dewar deals in his paper.

It is editorially explained in a foot note that Prof. Dewar's health having been impaired by overwork, only the first portion of the article was written by him; but the material furnished by him for the completion of the paper has enabled an account of his experiments, in lines indicated by the title, to be prepared.

The effects of the extremely low temperature obtainable by the evaporation of liquid oxygen, which, as Prof. Dewar has shown is capable of condensing atmospheric air to a liquid and even congealing it, modify some physical properties which bodies manifest at ordinary temperatures and this in quite unexpected ways. For instance, contrary to general anticipation the property of elasticity is found to be much increased.

"This modification of elasticity—both longitudinal and torsional—was clearly shown by cooling spirals of very soft metal in liquid oxygen to —180° C., when they became perfectly rigid and sonorous, like iron. The influence of similar cooling upon hard steel was demonstrated by comparing the notes from two tuning-forks in perfect unison. On cooling one to —180° C. its elastic constants were modified, thus causing it to vibrate more quickly than the other, while the number of beats showed the increased elasticity."

Direct chemical reaction, and voltaic action appear to cease at a temperature of 180° C. (93° C. above the absolute zero); but photographic effect is continued at — 200° C., its energy, however, being diminished 80 per cent.

Color is also affected; for example liquid oxygen turns red, and iodide of mercury turns yellow

But the most remarkable effects, if any can be called more remarkable than others, are those pertaining to phosphorescence or fluorescence. In these experiments another example of the insight afforded by extreme conditions in physical researches, is added to that of Prof. Crooke's experiments with extremely attenuated gases, and to those of Tesla with rapidly alternating electric currents.

"Gellatin, celluloid, paraffin, ivory, horn and India-rubber become distinctly luminous, with a blueish or greenish phosphorescence, after cooling to —180° C., and upon being stimulated by the electric light. Hydrokinone is more luminous than the isomeric resorcin or pyrocatechin; in the same way pyrogallic acid was shown to be faint as compared with phloroglucin. All alkaloids forming fluorescent solutions become phosphorescent at low temperatures. The hydrocarbons, alchols, acids and ethers of the fatty series are all more or less active, and glycerin, sulphuric, and nitric acids are all very bright, whilst concentrated hydrochloric acid and strong ammonia are also very bright. Colored salts generally show very little activity. Water when pure is only feebly phosphorescent, but remarkably so when impure. Acetic acid and acetanide appeared fairly equal in luminosity; hippuric acid was very fine, and so were most substances containing a ketone group. Lithium platino-cyanide changed from white to red on cooling, and was excelled in phosphorescing power by yellow ammonium platino-cyanide, which was exceedingly bright.

"Definite organic substances possessing exceptional powers of phosphorescence, when stimulated at —180° C., are acetophenone, benzophenone, asparagin, hippuric acid, phthalic anhydride, urea, cretin, urethane, succinimide, triphenyl methane, diphenyl, salicylic acid, glycogen, aldehyde, ammonia, etc.

"Very remarkable were some results obtained by the professor with an egg and a feather. The egg shone brilliantly as a globe of blue light, its outline in the darkened theater being clearly seen. Other organic substances giving excellent results were cotton, wool, paper, leather, linen, tortoise shell, and sponge, all of which phosphoresced brightly, as did also a white flower, a cultivated species of dianthus. Colored glasses and papers do not, as a rule exhibit any phosphorescence, and when the alchols are colored by the addition of a trace of iodide, the luminous effect is destroyed. Milk was shown to be highly phosphorescent and much brighter than water. Metals also phosphoresce, but in this case the action is due to some organic film deposited from the air, because it disappears on ignition. If the metal is subsequently touched, the phosphorescence reappears."

Ordinary albumen is more phosphorescent than the yolk of egg. In general, however, white bodies are found inferior to colored ones in this respect. "Caustic soda and many salts not normally phosphorescent are markedly so at low temperatures."

The physical significance, if any there be, of these new facts as related to the ultimate nature of matter is, of course, yet to be made the subject of scientific speculation. They are too recent to determine whether any new light will be shed by them upon atomic conditions, which the Marquis of Salisbury in his inaugural address before the Royal Institution included among the yet "unsolved problems of science."

Utilization of Waste Carbonic Acid Gas in Breweries.

It is said that the quantity of carbonic acid (carbon dioxide) evolved during fermentation is approximately equal in weight to the alcohol produced. Mr. A. Marcot, in the Transactions of the Brewing Institute, describes the method and apparatus employed for collecting and compressing this formerly waste product, and an abstract of his paper is given in the *Scientific American Supplement*. The rapid evolution of the gas begins in breweries about 20 hours, and in distilleries about 6 to 8 hours, after "pitching," and for some time afterward continues at such a rapid and regular rate that it can be drawn off by the compression pumps without admixture of air. If however air is introduced, it can be got rid of by a special release valve. A parachute or skimmer is used to collect the gas, provided with raising and lowering gear that keeps it just above the level of the yeast. The level of the carbonic acid is shown by a collodion balloon which floats upon its surface.

After compression to one atmosphere the gas is purified by passing through water, sulphuric acid and a week solution of potassium permanganate. In the third stage of compression the pressure reaches 60 atmospheres and the gas then passes to condensing coils cooled by water and is liquefied. Obtained in this way, it has a purity of 99.5 per cent. and is odorless. At the plant described the liquefied gas is used as a source of power in place of the ordinary pumping engines. It has also a commercial value for a variety of purposes, from aërating water and bread to hardening armor plates.

Electrolytic Production of Chlorine and Soda.

In the November issue of this Magazine (p. 317) an article by Mr. H. Y. Castner on the electrolysis of alkaline chlorides, published in the *Engineering and Mining Journal*, was commented upon. M. Emile Andresoli now communicates to the *Electrical Review* some remarks upon the subject which might appropriately be called caustic. With some slight implied disparagement of electrolytic methods thus far employed for the purpose, he remarks that "it is usual for people who write or deliver lectures on the production of chlorine and caustic soda by electrolysis to predict that the Leblanc and Solvay processes are doomed, and that a new system has been found which will revolutionize the alkali industry, and supersede everything which has been done up to the present." He then refers to an article in the London *Times* upon the new electrolytic process as showing rather too much enthusiasm for an apparatus "which is so superior, so efficient, so cheap, and so perfect, that all the others are nothing in comparison with it."

Electrolytic methods for producing chlorine and caustic soda are grouped into three classes: (1) The decomposition of chloride solution with electrodes not absorbing the products of electrolysis; (2) the mercurial process, in which mercury is used as a cathode to form a sodium amalgam; (3) the dry process, or electrolysis of fused chloride of sodium or potassium. The Castner process belongs to the second category, and its novelty consists in the continuous tilting or rocking of the tanks, to give the mercury a flowing motion from side to side. It is a continuous process, and M. Andresoli says that a non-continuous one would be worthless; but that there are other continuous methods of the same class.

The author admits that the day is perhaps not far off when the electrolytic process will compete with the chemical manufactures as much as, or more than, electric lighting does with gas; but doubts whether present electrolytic methods themselves will not be superseded long before that day. As to the "dry" processes, "the sole question is to know how the electrolysis of fused salt will behave on a commercial scale."

Incidentally, in adverting to the *Times* article, M. Andresoli contends that the technical press ought to be the first to investigate and appreciate new discoveries, and thinks that "it is almost a breach of etiquette for the daily newspapers to trespass on the ground of the technical press and to give the assistance and prestige of an advertisement in a largely circulated paper," etc. Here is revived an old controversy in which there is always room for argument.

In "Responsibility in Crime from the Medical Standpoint" (*Pop. Sci. Monthly*, Dec.), Dr. Sanger Brown makes the propositions, that the functional product of brain is mind, and that prevention of crime results from inhibitory brain centers established by means he sets forth.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

25800. The Lardarelo Boric Acid Works (Sc A S–Oct. 13.) 700 w.

26674. Erection of the Battle Monument, West Point, N. Y. (E R–Nov. 10.) 1400 w.

*26714. Technical Education (E–Nov. 2.) 1400 w.

*26722. Note on a Collection of Carboniferous Trilobites From the Banks of the Hodder, Near Stonyhurst, Lancashire. Ill. Henry Woodward (G M–Nov.) 2800 w.

*26723. Yumuri Valley of Cuba—A Rock Basin. J. W. Spencer (G M–Nov.) 800 w.

*26724. Problems Connected With a Cooling Earth. Arthur Vaughan (G M–Nov.) 1800 w.

*26725. The Volcanic Phenomena of Vesuvius and Its Neighborhood (G M–Nov.) 1400 w.

*26754. Mr. H. Y. Castner Replies to Criticisms Concerning His Electrolytic Process of Producing Soda and Chlorine (Inv–Nov. 3.) 1400 w.

*26755. A New Method of Reducing Metallic Oxides. H. W. Greene and W. H. Wohl (Inv–Nov. 3.) 500 w.

*26757. Youth of Great Inventors (I C B–Nov. 2.) 3000 w.

*26771. Past and Present. T. H. Huxley (N–Nov. 1.) 2400 w.

*26772. On Recent Researches on the Infra-Red Spectrum. S. P. Langley (N–Nov. 1.) 4500 w.

*26774. Cathode Rays (E R L–Nov. 2.) 1500 w.

26790. Management of Men—A Consideration of Executive Functions. B. F. Spalding (A S–Nov. 10.) 2500 w.

26820. The Prevention of Noise (Sc A–Nov. 17.) 700 w.

*26837. Technical Education (A L–Nov. 2.) 1200 w.

26857. How to Build a Town—An Object Lesson From the Pacific Slope. J. C. Ransom (T–Nov. 15.) 1000 w.

26877. A New Disinfectant—Formalin. Louis Stern (An A–Nov. 18.) 600 w.

26866. The New Engineering Building at the University of Illinois. Ill. (E N–Nov. 15.) 900 w.

†26919. Fluorescence or Phosphorescence,

and Photographic Action at Low Temperatures—Professor Dewar's Latest Experiments (N S R–Oct.) 1600 w.

†26920. Mental Training—A Remedy for "Education." William George Jordan (N S R–Oct.) 6000 w.

†26921. "The New Element of the Atmosphere"—Considered by Professor Dewar (N S R–Oct.) 1000 w.

*26958. The Technology of Explosives. W. J. Orsman (I C T–Nov. 9.) 3500 w.

*26987. The Search for a Unit of Light. O. Lummer and F. Kurlbaum (El–Nov. 9.) 1500 w.

†26995. Hermann von Helmholtz. Arthur W. Rücker (F R–Nov.) 5000 w.

27016. The Scientific Applications of Photography. (Extract.) Henry Trueman Wood (Sc A S–Nov. 24.) 1300 w.

†27053. Responsibility in Crime from the Medical Standpoint. Ill. Sanger Brown (P S M–Dec.) 2700 w.

†27054. The University as a Scientific Workshop. Freidrich Paulsen (P S M–Dec.) 6500 w.

†27055. The Ancient Outlet of Lake Michigan. W. M. Davis (P S M–Dec.) 7400 w.

†27056. The Geology of Natural Scenery. Frederick J. H. Merrill (P S M–Dec.) 2700 w.

*27095. Tariff Changes and Customs Regulations.—Russia, the Netherlands, East Indies, Switzerland, Belgium, France, Spain, Italy, Bulgaria, United States, Hayti, Guatemala, Brazil, Cape Colony (B T J–Nov.) 4400 w.

*27108. Some Important Experiments With a New Explosive (Inv–Nov. 17.) 900 w.

27139. The Awning Over the Colosseum in Ancient Rome. Henry T. Blake (Sc A–Dec. 1.) 1800 w.

27142. On Some Magnetic Characteristics of Iridium. S. H. Brackett (Sc A S–Dec. 1.) 900 w.

27143. The Koniscope. J. G. McPherson (Sc A S–Dec. 1.) 1700 w.

27144. The Horse as a High Speed Engine. R. H. Thurston (Sc A S–Dec. 1.) 3000 w.

†27152. Atmospheric Resistance. Walter L. Webb (P E C P–Nov.) 3300 w.

†27167. Suggestions for an Index of Engineering Literature. George D. Shepardson (T A I E E–Nov.) 2200 w.

*27243. The World's Debt to Astronomy. Simon Newcomb (Ch–Dec.) 3500 w.

*27252. The Use of Explosives for Mechanical Flight (Inv–Nov. 24.) 2000 w.

27266. Analysis of Electrolized Water Pipes. Joseph Rigge (A G L J–Dec. 3.) 1600 w.

27280. Weathering of Fuel. William White, Jr. (R A–Nov. 30.) 1600 w.

*27290. Alexander Siemens' Presidential Address to the Institution of Junior Engineers (El–Nov. 23.) 4800 w.

*27296. The Construction of Engineering Formulæ. Frederick Grover (P Eng–Nov. 23.) 800 w.

†27313. On the Gunning Method for Tota Nitrogen in Fertilizers. W. E. Garrigues (J A C S–Dec.) 700 w.

*27331. Recent Improvements in the Chemical Industry (I C T–Nov. 23.) 1600 w.

†27332. Schiaparelli on Mars (N–Nov. 22.) 5300 w.

27353. The Search for the Absolute Zero. Ill. Henry J. W. Dam (P A–Dec. 1.) 3800 w.

†27373. Inversion of Temperatures in the 26 68 Day Solar Magnetic Period. Frank H. Bigelow (A J S–Dec.) 4000 w.

†27374. The Duration of Niagara Falls. J. W. Spencer (A J S–Dec.) 5800 w.

†27376. Distribution and Probable Age of the Fossil Shells in the Drumlins of the Boston Basin. W. O. Crosby and Hetty O. Ballard (A J S–Dec.) 3600 w.

*27380. Why Is Artificial Flight So Difficult of Invention? Ill. Otto Lilienthal (A E R J–Dec.) 2200 w.

†27390. The Determination of Melting-Points and the Composition of Some Candle Material. W. E. Garrigues (J A C S–Dec.) 1400 w.

27400. The Influence of Occupation on Eyesight (Sc A–Dec. 8.) 1100 w.

27403. Use of Photography in Topographical Drawing. Ill. A. Laussedat (Sc A S–Dec. 8.) 2200 w.

27406. Economic Entomological Work in the Aaks of New York City. E. B. Southwick (Sc P S–Dec. 8.) 1400 w.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I–Began May—9 parts to date—45 cts. each).

24462. Graphic Statics. W. W. F. Pullen (P Eng–Began Aug. 10—8 parts to date—30 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng–Began Oct. 13—4 parts to date—15 cts. each).

26050. Some Remarks on Modern Naval Tactics. By "A Captain of a Battle-ship" (E–Began Oct. 12—Ended Nov. 2—4 parts—30 cts. each).

26560. Indiana Industries (Ir Age–Began Nov. 8—2 parts to date—15 cts. each).

26759. Mosaics. B. Bentley Young (I C B–Began Nov. 2—Ended Nov. 9—2 parts—30 cts. each).

26984. Optical Activity as a Guide to Chemical Constitution. William Huntington (C T J–Began Nov. 10—Ended Nov. 24—3 parts—30 cts. each).

26996. Statistically Indeterminate Structures and the Principle of Least Work. Ill. (E–Began Nov. 9—2 parts to date—30 cts. each).

27084. Early British Races. Ill. J. G. Garson (N–Began Nov. 15—2 parts to date—30 cts. each).

27198. Refrigeration and Ice making (S E–Began Nov.—1 part to date—15 cts).

COMMENT & CRITICISM

A Flying Machine That Flies.

ANNOUNCEMENTS reaching us from England indicate hopeful progress in the completion of Mr. Maxim's flying machine. Here, at last, is a machine that "in its proper motion," ascends. Hitherto the trouble with flying machines has mostly been that they had to be held up by some independent outside force. It is quite refreshing to hear now of one that has to be held down during experiment, and it is quite evident that Mr. Maxim has solved the problem of rising in the air, sustaining, and propelling by power supplied from a motor carried by the machine.

But how about the alighting? There seems to remain a set of problems that, in so far as the machine or the results of the trial give any indication, remain yet unsolved.

In the department of "Popular Miscellany" page 418, Vol. 1, of this magazine, I had the pleasure of writing with reference to this machine and its gifted inventor that the problem of the flying machine "has at last been taken up by exactly the right man who has gone about its solution exactly in the right way." This remark was partly based upon personal acquaintance with Mr. Maxim, and some knowledge of his methods in attacking mechanical problems. The same considerations warrant the belief that the difficulties in safely bringing down his machine to terra firma have not been overlooked by him, and to the anticipation that some very original and ingenious contrivances which will secure the desired result, will be the outcome of his studies on these problems.

L. ALLEN.

Brooklyn, 1894.

Power for Cotton Mills.

IN the November number of THE ENGINEERING MAGAZINE is a very interesting account of the Great Dam at Austin, Texas, and in it Mr. J. T. Fanning, C. E., is reported as saying, "450 horse-power will run a cotton-mill with 50,000 spindles on cloths adapted to the local jobbing trade." Now there is a great error here, either in some one's quotation of Mr. Fanning, or Mr. Fanning's quotation from some one else, as stated.

The lowest amount of power used in New England is at Fall River, on cheap print cloths, all "mule spinning," where I have found it as low as 15 horse-power per 1000 spindles. From that it runs up to 30 horse-power per 1000 spindles, on coarse goods, at Lowell and Manchester on "frame-spinning," such as is generally used at the south. This would give in one case 750 horse-power, and in the other 1500 horse-power for 50,000 spindles, and as I understand the general run of southern mills, it would not be safe to estimate on less than 25 horse-power per 1000 spindles, 1250 horse-power for a mill of 50,000 spindles, instead of 450 as quoted.

SAML. WEBBER.

Charlestown, Mass.

Currency Reform.

BY your December number I notice that you advocate the so-called "Baltimore Plan of Currency Reform." This plan should more properly be called "Currency Deform"; the idea of handing over to the banks complete control of the power of association, the power of the people to exchange services, commodities, and ideas among themselves, being simply monstrous and wicked. It is not so much reformation of the currency which is needed as the putting of a curb on the banks, and preventing them from over-trading in times of ease and placing the business of the country on a certain basis, to be followed by contraction and ruin on another basis in times of peril,—a peril generally created by the banks themselves. Every financial crisis is simply a bank crisis resulting from overtrading, followed by an attempt to undertrade.

After the destruction, the misery, the demoralization and the crime caused by the banks, especially those of New York city, in 1893, it requires a vast amount of assurance, not to say *brass*, on the part of those banks to propose to the American people a reform in the currency, by placing more power of destruction in the hands of those wretches.

The currency is all right, so far as it goes; its one and only defect being that there is not enough of it; the sole trouble existing in a surplus in 1893 of *bank-wind*, followed by a famine of *bank-wind*.

Since the commencement of your magazine you have given countenance to the fallacies of Mr. Edward Atkinson, of Boston, whose fallacies have been effectually and finally turned down by the elections of this year. Take a lesson by this experience of the Atkinson philosophy and proceed slowly in advocating even a more vicious and more selfish philosophy of the bank-ring of New York.

HENRY CAREY BAIRD.

Philadelphia, Dec. 5, 1894.

Steam Engine Governors.

REFERRING to article on Steam Engine Governor in your October issue, I would refer you to a paper by F. M. Rites read before the American Society of Mechanical Engineers, and forming part of vol. 14 of the Transactions, in which the author by mathematical methods attempts to show the preponderance of inertia effects over those due to centrifugal force in an especial form of shaft governor. The question as to whether one set of forces is of more importance than another or acts quicker is not thereby demonstrated to the satisfaction of all.

While it is conceivable that a shaft governor may be so designed that the inertia moments may be in the same direction and supplementary to those of the centrifugal forces, it is evident from an inspection of the cut 5 in the article, that there is but one direction of rotation in which this would be true of the form shown, and that the leverage or moment arm of the tangential component of inertia is in that case small as compared with the leverage of the centrifugal force. It is evident that the forces of whatever nature are given a large leverage on the eccentric connection to weights at the same time that the point of connection is so made that a small movement of weights causes a larger movement of eccentric. The eccentric pivot and pivot of weights are supported rigidly from the engine shaft, and that therefore in order to move the eccentric the balls or weights must change position, a fact in direct opposition to the principle of the Siemens governor. While the tangential inertia of the weights acts through small leverages and varies only directly as the velocity, the centrifugal force varying as the square of the velocity and acting through large leverage would have a preponderating influence. I have a firm conviction that too much importance is placed on the effects of inertia in this style of governor and that the results obtained are due more to the arrangement of leverage through which the forces act than any other one cause.

The question of close regulation is one of growing importance and anything relating to the subject coming from men of experience is interesting.

J. C. HOBART.

Cincinnati, Ohio.

NEW BOOKS OF THE MONTH

PUBLICATIONS OF THE LICK OBSERVATORY OF THE University of California, printed by authority of the Regents of the University. Vol. 3, 1894. Sacramento State Office: A. J. Johnson, Supt. State Printing, 1894. [Cloth, 4to, 229 pp., and 16 full size plates.]

THE book comprises four parts: Part I. Selenographical Studies, based on negatives of the Moon taken at the Lick Observatory by Prof. L. Weinek. Part II. Report on Specimens of Crown and Flint glass belonging to the Lick Observatory and manufactured by the Messrs. Feil; by Prof. C. S. Hastings. Part III. Investigation of the Glass Scale "A," of the Lick Observatory Measuring Engine; by Mr. O. H. Tittmann. Part IV. Spectroscopic Observations of Nebulæ, made at Mount Hamilton, Cal., with the 36-inch Telescope of the Lick Observatory; by Prof. J. E. Keeler. A list of works issued by the Lick Observatory and a list of errata complete the text.

In the first part the splendid heliogravure illustrations deserve special mention. These are: (1) Heliogravure from a photograph of the moon, taken two days after the first quarter, in the focus of a 36-in telescope (not enlarged); (2) From a drawing of *Mare Crisium* and vicinity, by Prof. Weinek (4-fold enlarged); (3) From a photographic enlargement of *Mare Crisium*, by Prof. Burnham (2-fold enlarged); (4) From a photographic enlargement of *Langrenus*, *Vendelinus*, *Petavius*, etc., by Mr. Colton (7-fold enlarged); (5) From drawings of *Archimedes* (2 views), and of *Arzachel* (2 views), by Prof. Weinek, (10-fold enlarged; (6) From a drawing of *Petavius*, by Prof. Weinek (20-fold enlarged); (7) Lithograph of Maedler's Chart of *Petavius* (reduced to the same scale as the preceding); (8) Heliogravure from a drawing of *Vendelinus*, by Prof. Weinek (20-fold enlarged); (9) From a drawing of *Langrenus*, by Prof. Weinek (20-fold enlarged); (10) From a drawing of *Copernicus*, by Prof. Weinek (20-fold enlarged); (11) Index map to the drawing of *Copernicus;* (12) Heliogravure from a photographic enlargement of the *Lunar Apennines*, by Mr. Colton (7-fold enlarged); (13) Index map to the *Apennines*, by Prof. Weinek; (14) Autotype, from a photographic enlargement of *Tycho*, by Prof. Weinek and Dr. Spitaler (24-fold enlarged); (15) Phototype of the drawing of *Capella* and *Taruntius*, C, by Prof. Weinek (40-fold enlarged), and (16) Lithograph of the *Visible Spectra* of Planetary Nebulæ, from drawings by Prof. Keeler. The book deserves great credit for the style in which it is printed, as well as the interesting character of its contents.

THE EVOLUTION OF MODERN CAPITALISM. A STUDY OF Machine Production. By John A. Hobson, M. A., author of "Problem of Poverty." London: Walter Scott, Ltd., 24 Warwick Lane. Charles Scribner's Sons, New York, 1894. [Cloth, 12mo, xvi.-383 pp. Price, $1.25.]

THIS book is an attempt to express and illustrate some of the laws of the structural changes in modern industry. The author says in his preface that he has chosen a focus of study between the wider philosophic survey of treatises on Social Evolution and the special studies of modern machine industry, contained in such works as Babbage's Economy of Manufactures and Ure's Philosophy of Manufactures, or more recently in Prof. Schulze-Gaevernitz's careful study of the cotton industry. He calls attention to the fact that the sub-title, "A Study of Machine Production" indicates a further narrowing of the investigation. A clearer recognition of organic unity is sought by dwelling upon the more material aspects of industrial change which mark off the last century and a half from all industrial epochs. The position here assigned to machinery as effected in industrial evolution is selected because the author thinks it is essential to choose some single clearly appreciable standpoint in bringing scientific analysis to bear upon phenomena so complex and so imperfectly explored. The book commences with an introduction, in which the following topics are discussed: Industrial Science, its Standpoint and Methods of Advance, as Factor in Modern Industrial Changes; Place of Machinery in Evolution of Capitalism; The Monetary Aspect of Industry; The Literary Presentment of Organic Movement.

In succeeding chapters The Structure of Industry before Machinery; The Order of Development of Machine Industry; The Structure of Modern Industry; The Formation of Monopolies in Capital; Economic Powers of the Trust; Machinery and Industrial Depression; Machinery as Related to Demand for Labor; Machinery and the Quality of Labor; The Economy of High Wages; The Effects of Modern Industry upon the Workers as Consumers; Women in Modern Industry; Machinery and the Modern Town; Civilization and Industrial Development; with many sub-topics are discussed.

ELECTRICITY ONE HUNDRED YEARS AGO AND TO-DAY. By Prof. Edwin J. Houston, Ph. D. New York: The W. J. Johnston Company, Ltd. [Cloth, 12mo, 186 pages, $1.]

THE basis of this little work is a lecture delivered some time before the Electrical Section of the Brooklyn Institute which was a running commentary upon the various steps of progress of the science from that time to this day, and suited to the lay mind. The subject was admirably handled both historically and otherwise and many pretty conceits introduced. One of these which particularly pleased those who heard the lecture was the simile drawn between electricity and Aladdin's wonderful lamp.

The present book contains the lecture in full, with copious additions chiefly of a historical character. In fact it may be said that the book is made up with historical data, to which have been added the lecture above referred to. But taking the lecture as a text he has added footnotes giving abstracts from the original papers whence he had received inspiration, and also extracts from contemporaneous writers. The book is, therefore, a very valuable compendium of historical incidents, facts and data, but it has been arranged so badly as to lose much of its value. There are footnotes within footnotes sometimes down to the third or fourth degree, and although an attempt has been made to distinguish the degree of descent of the footnote by difference of type it is often difficult to distinguish the one from the other. The author was apparently fully aware of this fault for he has deemed it necessary to apologize in his preface for the shortcomings of his publisher.

The book however is a very readable one, and were it not for the glaring faults of arrangement referred to could be praised.

THE METAL WORKER ESSAYS ON HOUSE HEATING BY Steam, Hot-Water and Hot-Air, with Introduction and Tabular Comparisons. Second Edition, Revised, New York: David Williams, 1892. [407 pp., 7 × 9½ inches Cloth. Price, postpaid, $3.00.]

THE foundation of this book is the text of prize essays—two on Combination Systems of Heating, four on Steam Heating Systems, three on Hot-Water Circulating Systems, and six on Hot-Air Systems which were written in response to prizes offered by *The Metal Worker* in the fall of 1888, and subsequently printed in *The Metal Worker*. They attracted much attention at the time of their appearance, and were commonly known and spoken of by the name chosen as a title for this book. The work, however, contains much more than these essays. Naturally, heating engineers did not agree with all the views of the writers of the essays, and criticisms upon them were made by a number of experts, emphasizing their strong points, and calling attention to deficiences. Thus supplemented the essays became in reality a practical treatise on the heating of dwellings, and as such was republished. The value and popularity of the book has been much enhanced in this second edition by a chapter on proportioning heating surfaces (written by an able heating engineer) Mr. John J. Hogan, in which no less than twelve series of rules are given, believed to comprise all the methods in use for ascertaining what must always be the first datum for planning a heating apparatus, viz., the amount of heating surface needed to do the required work.

MECHANICAL DRAWING. PROJECTION DRAWING; Isometric and Oblique Drawing; Working Drawings. A Condensed Text-book for Class-Room Use By Walter K. Palmer, M. E., Department of Drawing, Miller Manual Labor School, Crozet, Virginia, Columbus, O.: Charles B. Palmer. [Cloth, 8vo, 50 p. $0.80.]

WHILE every competent instructor in mechanical drawing has his own ideas as to the peculiar requirements of his pupils, and prefers to exercise his own judgment as to the best methods of instruction in the details of the art, there are nevertheless certain fundamental principles and general rules which must always be presented in much the same way. This work has evidently been prepared with much care by a skillful instructor, to serve as an elementary text-book in the class-room, and as a manual of reference for the future use of the pupil. Its aim is to guide the student to develop for himself the essential principles of the art in a natural and progressive order, and to make his own illustrative drawings as he goes along. The course of instruction laid out appears to be admirably adapted to form in the mind of the student a habit of working from a knowledge of principles, instead of merely copying in a mechanical way, the examples which may be placed before him. The work is very handsomely printed.

THE TELEPHONE HAND BOOK. BY HERBERT LAWS Webb, Member Am. Inst., E. E., Inst., E. E. London. Author of Practical Guide to the Testing of Insulated Wires and Cables. First edition; Chicago: London Publishing Company, 1894 [Cloth, 146 pp., 3x6½, price $1.]

THIS little book is from the pen of an esteemed contributor to THE ENGINEERING MAGAZINE and he is widely known as a writer on electrical subjects. Mr. Webb states in his preface that this is the first practical book on American telephone methods. As such it will doubtless be acceptable to American readers, especially those interested in telephony. The book is based entirely on standard American practice, and most of the material, apparatus and methods described are peculiar to or have originated in the United States. Nevertheless, a few chapters dealing with certain forms of transmitters and receivers used in Europe are given for the information of those who are unfamiliar with other types of instruments than those used in the United States. Although the pages are small and the book contains only 146 pages, five of which are devoted to the index, the publishers have managed to crowd into it a considerable amount of matter by using small type.

THERMODYNAMICS OF REVERSIBLE CYCLES IN GASES and Saturated Waters. A full synopsis of a ten weeks' undergraduate course of lectures delivered by M. I. Pupin, Ph. D. Arranged and edited by Max Osterberg, of Columbia College. New York: John Wiley & Sons: 1894. [Cloth, 12mo, 114 p., $1.25]

THIS is a theoretical introduction to the study and design of heat engines. The treatment is necessarily based on the mathematical formulæ which have been established—partly by experience, and partly by inference—that determine the underlying principles on which heat engines of all kinds, whether driven by steam, gas, or other expansive agency, are built. The work does not refer definitely to these applications of force by name, but presents a general grounding in the elements of both the science and the art of developing power from heat. Every added treatise on thermodynamics—upon which all our modern mechanical progress, whether of steam, electricity or otherwise depends—is a distinct gain, when at least up to the mark of the excellent manual.

BROWN'S DIRECTORY OF AMERICAN GAS COMPANIES GAS Statistics. Compiled and Corrected by E. C. Brown, Progressive Age, 280 Broadway, New York, 1894. [8vo, pp. 159-xxxvi. Price $5.00.]

BESIDES being the most comprehensive and accurate directory of gas companies in America yet published, this book contains a vast amount of statistical information. Not only are the names of the different companies given in the usual alphabetical order, but the amount of capital stock and total bonds outstanding; names of officers; purchasing agents; process of manufacture; population of district supplied; average price of gas for 1894; number of public lamps; price of lamps; lighting hours per lamp, per annum; approximate annual output; candle power, and lowest pressure available for gas-stoves, etc., are also given.

A TREATISE ON ELEMENTARY HYDROSTATICS. BY JOHN Greaves, M. A., Fellow and Lecturer at Christ's College, Cambridge. New York: Macmillan & Co. 1894. [Cloth, 12mo, 204 p., with diagrams. $1.10.]

THIS is a well arranged, closely classified mathematical treatise on hydrostatics, in which however the author relies on mathematics but does not use the calculus, for the most part. It is a text-book rather than a work of reference, and was prepared for the use of Cambridge students. The discussion is applied in detail to the various forms of machines and appliances, and to the principal phenomena of the science. The sections are arranged mainly in the form of definitions and problems, as they would come up in class work.

THE ELEMENTS OF GRAPHIC STATICS. A TEXT-BOOK for Students of Engineering. By L. M. Hoskins, professor of pure and applied mechanics in the Leland Stanford, Junior, University; formerly professor of mechanics in the University of Wiscousin. New York and London: Macmillan & Co. [Cloth, 8vo, viii+191 p. With diagrams. $2.25.]

IN harmony with the modern practice of engineering, which in every direction aims to simplify work and condense results, Mr. Hoskins has compiled this treatise on graphic statics, in which the diagrams illustrating the relations of stresses and spaces have been based on Bow's well-known notation. The author however has widely extended the application of the original notation. He has also endeavored to comply, as to methods of usage in regard to the technical terms of mechanics, with that of the standard authorities—which is gradually crystallizing into something like a system. Graphic statics apply more especially in the designing, or the criticising, of roof and bridge work, and so form a salient part of modern civil engineering. There is an extension, however, which Mr. Hoskins' admirable work suggests, of the application of the system to machine building, and, in fact, to a larger variety of uses.

BOOKS RECEIVED.

Barrett, P. J. = Electricity at the Columbian Exposition. Including an account of the Exhibits in the Electricity Building, the Power Plant in Machinery Hall, the Arc and Incandescent Lighting of the Grounds and Buildings, the Transmission of Power for the Operation of Machinery, the Subway and Conduits, Electric Fountains, Search Lights, Intramural Roads, Electric Launches, Electric Elevators, Lighting of the Ferris Wheel, Corona Lighting of the Manufactures Building, etc. Chicago: R. R. Donnelly & Sons Co., 1894. [Cloth. 8vo. xv-501 pp.]

Annual Report of the State Engineer and Surveyor of the State of New York for the Fiscal Year Ending September 30, 1893, transmitted to the Legislature January 22, 1894. Albany: James P. Lyon, State Printer, 1894. [Cloth. 8vo. 460 pp.]

Reece, Benjamin = The Cattle Guard Problem. Together with the Law of Cattle Guards and Railroad Fences, Containing Statutes and Decisions of the States of the Union. The Q. & C. Company, Chicago, and New York. [Pamphlet. 8vo. 70 pp.]

Statistics of the American and Foreign Iron Trades for 1893. Annual Statistical Report of the American Iron & Steel Association, presented to the Members September 1, 1894. Philadelphia: The American Iron and Steel Association, 1894. [Pamphlet form. 8vo. 78 pp.]

Fox, Walter C., C. E. = Transition Curves. A Field Book for Engineers. Containing Rules and Tables for Laying Out Transition Curves. New York: D. Van Nostrand Co., 1893. (No. 10 Van Nostrand Science Series.) [Cloth. Price $50.]

Interstate Commerce Commission. = Sixth Annual Report on the Statistics of Railways in the United States for the year ending June 30, 1893. Prepared by the Statistician to the Commission. Washington: Government Printing Office. 1894. pp. 620. 9×6 inches, Cloth.

Annual Report of the City Engineer of Toronto for 1893. Toronto: J. Y. Reid, City Printer. 1894. pp. 125. 9½×6 inches. Appendices A, pp. 25, B, pp. 33, C, pp. 23, D, pp. 8.

Snell Albion T. = Electric Motive Power: The Transmission and Distribution of Electric Power by Continuous and Alternate Currents. With a Section on the Applications of Electricity to Mining Work. London: The Electrician Publishing Company, Limited. 1894. pp. 397. 7½×5½ inches. Cloth. Price 10s 6d.

Department of the Interior, Census Office. Robert P. Porter Superintendent, Carroll D. Wright, Commissioner of Labor in Charge. Compendium of the Eleventh Census: 1890. Part II: Vital and Social Statistics. Wealth, Debt, and Taxation; Mineral Industries; Insurance; Foreign Born Population; Manufactures. Washington. Government Printing Office. 1894. pp. 1064 11½×7½ inches. Cloth.

Winchell, Alexander. LL. D. Late Professor of Geology and Paleontology in the University of Michigan. = Walks and Talks in the Geological Field. Revised and Edited by Frederick Starr, of the University of Chicago. Flood and Vincent. The Chautauqua Century Press. Meadville, Pa. 1894. pp. 353. 7½×5 inches. Cloth.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

S. Wilks Manufacturing Co., Chicago, Ill., U. S. A.=Catalogue, 34 pp. [Steam Generators, Hot Water Heaters, Steel Tanks, etc. For supplying hotels, dwellings, greenhouses, laundries, churches, baptisteries, bath houses, carriage houses, etc., with steam and hot water. Profusely illustrated, with price lists, etc.]

Chas. A. Strelinger & Co., Detroit, Mich., U. S. A.=Catalogue, 306 pp. [A long list of a great variety of bench tools for use in screw cutting, tapping, countersinking, etc. Also milling and gear cutting tools, knurling tools, wrenches, screw drivers, tapes, levels and levelling instruments, hydraulic jacks, emery wheels, punches and punching presses, etc., etc., etc., with price lists.]

The Acme Machinery Co., Cleveland, Ohio, U. S. A.=Catalogue, 108 pp. [Beautifully printed and bound in flexible covers with imprint in gold, and rounded corners. Describes and illustrates an extensive list of bolt cutting machines, taps and dies, with price lists.]

The Vulcan Iron Works Co., Toledo, Ohio, U. S. A.=Catalogue, unpaged. [Steam Shovels and Dredges. Sheets eyeletted together with flexible leatheroid covers, gold imprint. Very elegantly designed ; rounded corners. Profusely illustrated with cuts of steam shovels, showing their appearance in operation and exemplifying details of construction.]

The National Switch & Signal Co., Easton, Pa., U. S. A.=Reference Catalogue No. 2, 154 pp., Royal octavo. [Tinted illustrations, flexible covers, imprint in silver, 64 full page plates, with numerous engravings illustrative of details. Describing interlocking and signaling apparatus manufactured by this company.]

Consolidated Car Heating Co., Albany, N. Y., U. S. A.=Catalogue, Part XII (1895 Edition), 30 pp. [Describes electric heaters, cable car heating, lighting by the Pope system, compressed oil gas for cable and steam cars, and by electricity for steam cars. Contains numerous illustrations of the applications of these systems to railway cars, and details of the appliances therefor.

The Ingersoll-Sargeant Drill Co., New York, U. S. A.=Advance sheets of Catalogue No. 50, 32 pp. exclusive of cover. [Illustrated with numerous engravings of coal cutting machines in operation, with sectional drawings illustrating all the parts in such machine assembled together, ready for work. Also a full page plate illustrating a shaft sinking plant. Also illustrations, descriptions and price lists of rock drilling machinery. On the last page of cover is an ex ellent illustration of an apparatus for pumping water by compressed air by the use of the Pohlé air lift pump. Special attention is called to a statement of the cost of blasting and loading coal at working face, keeping track laid and timbers set in rooms, on page 17 of this catalogue.]

The Sargent Co., Chicago, Ill., U. S. A.=Pamphlet, 11 pp. "The Wheel, the Rail and the Shoe." [The purpose of this book is to show by a description and argument, with the use of liberal Illustrations and diagrams, the advantages of the Sargent Brake Shoe. All the features of the design of this shoe and its evident advantages are excellently presented.]

H. W. Johns Manufacturing Co., New York, Chicago, Boston, Philadelphia, U. S. A. London, Eng.=Pamphlet, unpaged. Heat Insulation and Fire Protection in Prominent Buildings. [Describing very briefly the uses of asbestos in fire proofing buildings and containing a large number of excellent illustrations of such applications in numerous and important buildings in most of the large cities in the United States.]

The Minneapolis Radiator and Iron Co., Minneapolis, Minn., U. S. A.=Catalogue, 48 pp. [Describes and illustrates a long line of appliances for steam and hot water heating, with tables of sizes and capacities, illustrations of details of construction, price lists, etc.]

The Butler Manufacturing Co., Chicago, Ill., U. S. A.=Catalogue, 37 pp. [Some electrical specialties manufactured by this company, among which are lamp hoods for any system, incandescent lamps, street fixtures and reflectors, weather protectors, switches, reflector shades, hanger boards, head lights, station lamps, terminals and connectors, screw cases, bolt cases, water coolers, etc.]

Boston Belting Co., Boston and New York, U. S. A.=Catalogue, 116 pp. [Price list of a very extensive line of rubber goods, including vulcanized rubber goods, machine belting, hose for fire department and domestic use, hose racks, rubber packing, rubber mallets, rubber valves, rubber soleing, rubber springs, corrugated rubber matting, perforated mats, rollers, etc., etc. Also a concise history of the company, and facts relating to vulcanized rubber machine belting, with suggestions for the transmission of power by rubber belting, constituting a complete essay upon the subject, which will be of value generally to mechanical engineers. Elegant cover printed in gilt and tints.]

Electrical and Mechanical Engineering & Trading Co., New York, U. S. A.=Pamphlet, 15 pp. [Describes the Booster System and gives other important electric railway information. The description is illustrated with engravings and the subject is also treated mathematically, with plate diagrams, showing initial cost of steam and generating plant, copper and special apparatus for delivering 200 amperes at 500 volts ; operating expenses of plant delivering 200 amperes at 500 volts ; comparison between common and Booster feed for railways, showing the investment saved in weight of copper by means of the Booster System, and a table of electrical conductors which comprises much general information for electric railways in compact and convenient form.]

Interior Telephone Co., New York, U. S. A. =Pamphlet, 40 pp. [Illustrating and describing the Colvin Interior Telephone System for inter communication between several departments, in any building, such as hotels, office buildings, stores, factories, steamships, residences, etc. With numerous testimonials and a list of parties using the System.]

Interior Conduit and Insulation Co., New York, U. S. A.=Circular and price list No. 20, 16 pp. [Describes and illustrates the iron armored insulating conduits and single tube systems of this Co., with all their details. Also a list of pipe cutters, pipe vices, hack saws, stocks and dies for threading pipes, pipe wrenches, etc.]

Fraser & Chalmers, Chicago, Ill., U. S. A. London, Eng.=Catalogue No. 24, Riedler Pumping Engines, 12 pp. [Illustrates and describes these noted mining and water works pumps, and gives an extensive list of places where they are in use. (2)=Catalogue No. 46, Riedler Air Compressors, 12 pp. Manufactured for the United States, Mexico, England, Africa and Australia. A full description of the same and illustrations of the vertical type, a list of catalogues of Fraser & Chalmers, English Editions, in order of numbers, and a discussion of the advantages obtained by the use of these compressors. Also unpaged leaflets describing and illustrating special installments.]

Star Brass Manufacturing Co., Boston, Mass., U. S. A.=Catalogue and Steam Users Manual, 190 pp. [Stiff cover, describes and illustrates an extensive line of pressure and vacuum gauges, marine pop safety valves, and general steam engine and boiler appliances, Also contains a variety of useful information relating to practical steam engineering.]

The Sperry Electric Railway Co., Cleveland, Ohio, U. S. A.=Catalogue, 38 pp. [Describes apparatus for electric railway use, manufactured by this Company. A gem of typographic art. Both the text and the cuts are printed in colors, and the cover is light blue with gold imprint united in a very artistic design.]

The Boston Belting Co., Boston and New York, U. S. A.=Catalogue, 29 pp. exclusive of cover. [Describes and illustrates a most extensive line of hose for all purposes to which hose can be applied. Also hose pipe, with notes of information, comprising tables of use in calculation of water pressures at engine through various lengths of hose, with different sized nozzles, pressure in pounds per square inch; velocity in feet per minute, and approximate height in feet to which a jet will be projected when water is discharged from various heights, capacity of cisterns and tanks, etc.]

Trevert, Edward.=How to Build Dynamo-Electric Machinery, Embracing Theory, Designing and the Construction of Dynamos and Motors. Illustrated. Lynn, Mass.: Bubier Publishing Co. [Cloth. 8vo. 3-339 p. $2.50.]

Unwin, W. Cawthorne.=On the Development and Transmission of Power from Central Stations: the Howard lectures delivered at the Society of Arts in 1893. New York: Longmans, Green & Co. [Cloth. 8vo. 5-312 p. $5 30.]

Ed Wertheim, Chicago, Ill., U. S. A.=German Asbestos Goods. 75 p. [Describes sources from which asbestos is obtained, its manufacture, uses, and methods of applying it to various purposes, including boiler coverings, belting, building paper, ropes and rope ladders for fire escapes, insulating tubes, etc.]

Siemens and Halske Electric Co., of America, Chicago, Ill., U. S. A.=1—Bipolar Generators and Motors, Type "L. H." 8 p. 2—Generators and Motors, Type "I." [Illustrated descriptions of both these types of machines and a statement of the advantages of each. Also large page engravings of notable machines erected and in use.]

Niagara Cycle Fittings Co., Buffalo, New York, U. S. A.=Catalogue. 16 p. [10 of which are occupied with accurate tables of diameters, areas, weights, etc., of Cold Drawn Seamless Steel Tubing. Calculated and published by O. J. Edwards, Ellwood City, Pa., 1894, copyrighted; all rights reserved in America and England.]

The Globe Company, Cincinnati, Ohio, U. S. A.=Catalogue of office appliances. 108 p., green and silver gilt cover. [Illustrates and describes a long line of office furniture, including filing cabinets, desks, and other office appliances, with price, and directions for ordering from special designs.]

Weber Gas and Gasoline Engine Co., Kansas City, Mo., U. S. A.=Catalogue, 39 pp. [Describes and illustrates the Weber Gas and Gasoline Engines, of various sizes and types, and adapted to various uses. Gives cost of operating, list of sizes, capacities, and other details, uses to which these engines are adapted; also a long list of testimonials from parties using them, with numerous illustrations, a notable one being that of an adaptation of the engine to the manufacture of ice, and the refrigeration used in a packing house in Kansas City; also another illustrating the application of this kind of power to electric lighting]

The Tanite Co., Stroudsburg, Pa., U, S. A. =Catalogue, 47 pp. [Contains an earnest plea for the better appreciation of the grinding industry. Presents an able argument favoring the substitution of grinding for the use of the file and cold chisel in all places where the solid emery wheel can be applied. Also presents practical hints about emery wheels by which their use and efficiency may be largely enhanced.]

The Addyston Pipe and Steel Co., Cincinnati, Ohio, U. S. A.=Pamphlet, 8 pp. "Altitude and Discharge of Fire Streams." [Diagrams, descriptive text and formulæ for the solution of all problems relating to Altitude and Discharge from Fire Nozzles. Both "Smooth" and "Ring" nozzles are treated. By Mr. John Hill, C. E. A little study of the diagrams in connection with the explanatory text will enable the reader to use them with facility, and to rapidly solve all questions comprised within the limits to which they have been constructed. A revised list of standard special fittings, and a table of weights of cast-iron pipe from 2 to 60 inches in diameter are appended.]

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REASONS WHY PRICES ARE LOW.

By Albert Williams, Jr.

SOME one wrote long ago that there could be no such thing as overproduction, meaning that there could not be too much of the good things of the earth,—that the trouble is that would-be consumers cannot obtain them. This may be all very well as an abstract proposition, but as an explanation for prevailing low prices it will hardly be deemed satisfactory by the producers and holders of the many staples which have fallen greatly. Such a statement has an attractive sound for those who prefer a striking generalization to a plain presentation of facts.

Various reasons, more or less plausible, have been adduced to account for the existing condition of things. On the whole, taking a long list of commodities of all sorts, it is apparent that the average scale has been far lower of late than in former years, but that in the case of a few items there has been an advance; and it will be found that in these exceptions is the real key to the situation. Among the specific causes for a decline in certain cases one—"hard times"—is evidently no reason at all, being about on a par with the children's argument, "because." To give a name to a fact, an event, or a condition, is not to ascertain its origin. Another reason offered is legislation; but, admitting that this has an effect in some directions, it will hardly be claimed that it applies in all or in very many.

The one great economic law of universal application is that of supply and demand. It is as firmly established as the law of gravitation. To advance it at this late day is to put forth an accepted truism; but to clearly understand its workings it is necessary to have in mind a clear definition of supply, demand, production, consumption, and similar terms, and to allow for the modifications which distance, time, cost of transportation and exchange, and also, sometimes, tariff and

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currency legislation bring in, thus tending to obscure the main underlying issue and make the whole subject seem more complicated than it really is. For that matter, if we should clear away these minor factors, it might be found that the one central law explains about nine-tenths of economic phenomena, and that the lesser disturbing factors taken altogether may be responsible for the other tenth.

The law is absolute, inflexible. But its operation is not immediate. Water seeks its level, but it requires time to reach it. So also prices ultimately reach their level, but the process takes time in overcoming local and temporary obstructions, and hence the results are not quite concurrent ; by the time a balance is established between supplies and rates at one place far distant from another, a further movement at the starting point again slightly disarranges the balance. It is very noteworthy that the earlier economists of the modern school had a vision so penetrating as not to be misled by apparent discrepancies. This is especially remarkable when it is remembered that, when the law was enunciated, the means of distribution were crude and imperfect as compared with those of to-day. Without railways and steamships, which meant that transportation across the North Atlantic occupied from three weeks upward, and that inland traffic was even more backward ; without the Suez canal and its relatively short route between the Orient and Europe ; without hundreds of modern facilities for moving and exchanging goods,—there were not only delays and added costs, but there were much larger local differences than at present. Even with quicker and cheaper transportation by sea and land and inland waters, these discrepancies still exist, but in far less degree. The rapid dissemination of intelligence by land-telegraph and cable, and for shorter distances by telephone, and the vastly-improved mail and express service, place all the important markets of the world in close touch ; and these latter facilities are at least as influential as better methods of moving freights. There are also improved methods of transacting business, simpler and more expeditious ; and international clearing-houses, with possibly uniform money units, will still further reduce local differences.

Practically, if not quite absolutely, the world is *one* in a commercial sense. Or, if allowance is made for all disturbing factors, this might be stated as an underlying law parallel with and explaining that of supply and demand. The commercial centers thrill in unison. A vibration in the London or Manchester cotton market is transmitted instantly to Charleston, New Orleans, Galveston, Alexandria, and wherever cotton is handled in quantity. There is also a reflex effect, beginning at each shipping-point and focusing in England, and affecting in turn every single market, until a balance is struck which would exhibit identical figures for equal grades everywhere, were it not for freights, commissions, differences in exchange, and so on. So it is with every staple of universal use.

But there are other influences that sometimes come into action. Among these are currency legislation, tariff legislation, reciprocity treaties, commercial retaliation, local prejudices, etc. Their combined effect is probably over-estimated, but they are made much of by the few who try to belittle the main economic law. In one instance a sharp controversy has been waged for some years. It is over the price of silver. Gold monometalists assert that, while adverse legislation has affected the price, this legislation was enacted because of the alarmingly increasing production. Silver men assert that legislation alone is to blame ; that the old ratio to gold could have been maintained, had not legislators become timid. The question is of a somewhat circular nature, and much depends upon the direction in which one goes. But, without going into its merits here, it may be well to reproduce a table published in the December issue of this magazine :

WORLD'S OUTPUT OF SILVER AND ITS COMMERCIAL RATIO TO GOLD.

	Production : Troy Ounces.	Ratio.		Production : Troy Ounces.	Ratio.
1873	63,267,000	15.92	1884	81,597,000	18.57
1874	55,300,000	16.17	1885	91,652,000	19.41
1875	62,262,000	16.59	1886	93,276,000	20.78
1876	67,753,000	17.88	1887	96,124,000	21.13
1877	62,648,000	17.22	1888	108,827,000	21.99
1878	73,476,000	17.94	1889	120,214,000	22.10
1879	24,250,000	18.40	1890	126,095.000	19.76
1880	74,791,000	18.05	1891	137,171,000	20.92
1881	78,890,000	18.16	1892	152,940,000	23.72
1882	86,470,000	18.19	1893	161,163,000	26.49
1883	89,177,000	18.64			

Commercial legislation may take the form of an import duty, an export duty, or bounties, complicated with discrimination for or against the products of particular countries. In the somewhat acrimonious debates over tariff matters in congress tons of statistics have been brought forward on different sides and over special items, among which wool and sugar have been especially prominent. The wool question has been complicated by the requirements of manufacturers for certain grades not produced in the United States, and also by the demand for cheaper woolen goods, which are now very low. That tariffs high or low, or no tariff, have a positive effect on local prices is unquestioned ; but the effect is often not at all what was expected. In order to intelligently discuss such intricate questions, it would be necessary to have exact statistics for the whole world, concerning a given commodity, in order to trace the movement of the product, the prices at all centers, and the influence of freight rates and many minor factors.

This cannot be done in detail here, but the assertion may be ventured that nothing has yet been shown to detract from the preponderating effect of the main economic law. However, a few figures here and there may be of interest in lieu of more complete statistics.

Wheat is one example of overproduction, in the sense that, while people in some places may be suffering for flour, it has been a poor crop for the producer. It is well known that production and visible supplies had been increasing rapidly for some time, and in December last it was anticipated that total stocks would again be larger at the January statement than in the previous year; but *Bradstreet's* final figures show that, while there were increased stocks in the United States and Canada of 17,000,000 bushels more than one year ago, 11,000,000 more than two years ago, and 49,000,000 more than three years ago, the falling-off from 1894 in European stocks was 22,200,000 bushels. This slight difference does not controvert the fact that, on the whole, the production for a series of years has enormously increased. Meanwhile the prices of No. 2 red winter wheat in New York have been: in 1892 (average), $90\frac{3}{4}$ cents per bushel; in 1893, $73\frac{7}{8}$ cents; in 1894, $61\frac{1}{8}$ cents These figures correspond with the drop in foreign markets. The simple fact is that wheat has been overproduced. It is raised over vast new areas in Argentina, Australia, and India, to say nothing of former sources.

Cotton is another staple that has been overdone. The acreage has been greatly increased, and with the corresponding augmented yield the price has been falling. Of late the change has not been so marked as that shown by comparison with the years when 12 cents and over was a common rate. In 1892 middling uplands at New York ranged from $6\frac{11}{16}$ to $8\frac{1}{4}$ cents; in 1893 this grade was quoted at $7\frac{13}{16}$ to $9\frac{3}{4}$ cents,—a small gain; but in 1894 the average lowest to average highest quotations were $6\frac{15}{16}$ to $8\frac{1}{4}$ cents. Statistics published by the *Commercial and Financial Chronicle* show that the total receipts of American cotton from September 1, 1894, to the close of the year (that is, since the end of the last season) were 5,096,098 bales, against 4,157,260 in the same period of 1893.

Iron and steel have also fallen to the lowest prices on record. At the beginning of 1894 No. 1 anthracite was $14 a ton; at the opening of 1895 it was $12, with other grades in proportion. The present rate of production is about 50 per cent. greater than a year ago.

Corn has been fairly steady, ranging from 54 cents in 1892, $49\frac{15}{16}$ in 1893, and $50\frac{15}{16}$ in 1894, when the failure of the crop in parts of Kansas and Nebraska stiffened prices somewhat.

Mess pork sold in New York at $11.52 as an average for 1892; at $18.35 in 1893; at $14.13 in 1894; and in the first week of January it sold up to $14.50. Beef is another of the provisions that has advanced in the face of the general lowering of prices. It averaged $6.86 at New York during 1892, $8.19 for 1893, and $8.16 for 1894. In the case of both these products the supplies in domestic markets have been lessening.

Flour has naturally followed wheat downward ; wool also shows a large decline. The provisions exhibit little change. Petroleum is a somewhat erratic product, and in this instance has risen against the general markets. If it were possible to quote accurate figures for the world's production of these and other products at this early period in the year, the relation between production and price would come out plainly. As it is, the general impression as to the several products is in harmony with the law.

A curious set of facts in support of a belief in the infallibility of the law of supply and demand is furnished by the operations of trusts, pools, and " combines." At first glance this might not seem to be so, for the object of such combinations is to control the markets and hold prices at a profitable point, or rather at a point as high as consumers will stand. Yet these attempts, if intelligently engineered, really do nothing more than restrict production, or, less frequently, widen markets,—that is, effect artificially what would in the long run occur in any event ; and, if planned without foresight, they antagonize natural laws. These attempts to regulate prices are usually more or less successful at first, and sometimes continue to be so for a long while, if the commercial ability of the managers is great and the loyalty of the members of a pool of producers is steadfast, and also if the management has such a firm grasp upon the situation that it can force the members to keep strictly within the rates or quotas that have been determined upon. If the stocks with which such an organization operates are small, prices can be held up pretty stiffly in the case of any commodity of general and necessary use ; if the stocks begun with are small, but are allowed to increase beyond limits, then at first the movement will be successful, but it will soon collapse ; if at any time the stocks held are large, it may be possible to maintain prices for a time, or so long as the original policy is adhered to, by selling only a certain small portion and holding the rest firmly ; but the mere knowlledge on the part of consumers that there are such large reserves will cause them to hold back, and will generally defeat the object of the pool in the case of all commodities, and certainly will if the goods in question can be done without for a season. An example of continuously skilful management on the part of a monopoly is furnished by the Standard Oil Company, which, no matter how much berated, has always had the good judgment to keep within bounds and not kill the goose that lays the golden eggs. An extreme case of flighty management was presented by the tin combine a few years ago, which forced prices to an exorbitant pitch for a short time, but, having large known stocks on hand and attempting to realize rapidly, broke the market with a stunning crash the moment large lots were offered for sale. It is impossible to artificially regulate production in the majority of cases, because the supply is too large, the producers too numerous to be controlled, or the demand too uncertain. In such instances, in the natural course of events, things shortly find a level, for the law is automatic as well as axiomatic. When prices fall so low that there is no profit in production, the producers gradually drop off,—the weaker ones first,—and prices begin to rise. When prices rise so high that there is a profit much beyond current interest rates, new producers come in, and old ones increase their capacity and output to the best of their ability, until production runs ahead of consumption, holders are forced to sell, producer and production fall off, and everything comes again to a normal equilibrium.

"Corners" are of a different order. They are attempts to control large visible supplies by cash purchases and futures or options. They fail oftener than they succeed, for the profits temporarily made are likely to be utterly swamped when the corner goes to pieces—as sooner or later it must inevitably.

The number and amount of business failures are valuable indices of the state of trade. In 1894, according to *Bradstreet's* reports, the number of failures in the United States was 12,721, as compared with 15,560 in the panic year 1893,—the greatest number ever reported; but a better showing is made by the total volume of indebtedness, which was only $140,505,000 in 1894, or about 37 per cent. less than in 1893, while the shrinkage in number of failures was 18 per cent. These figures show that, while trade is still dull, it is on a much sounder basis than in 1893. In the cases where prices have declined since 1893 the fall cannot be ascribed to any fresh panicky feeling, but must be due to some other cause.

Another symptom of the condition of trade is afforded by comparative statistics of bank-clearings. In 1894 the total clearings at thirty-five cities of the United States were $44,993,611,293, or 16 per cent. less than in 1893, and 27 per cent. less than in 1892, in which year the largest total was recorded. The total for 1894 was the lowest for nine years. In 1894, and also in 1885, the shrinkage followed upon a year of panic. The decrease is not an unhealthy sign, being due to the slowness with which trade recovers from a collapse. In fact, during times of commercial disaster there may be heavy clearings, due to the efforts to realize and to adjust balances. The heavy decrease in bank clearings last year simply means that trade was dull and transactions curtailed. For the current year it is anticipated that the figures will begin to increase again.

It is noticeable that improvements in volume of business and in prices are always (leaving out of consideration for the moment artificial and sporadic upheavals caused by corners, trusts, and pools) much more gradual than the declines, but are accompanied with small, though sharp, intervening downward reactions brought about by speculators who have got in on a lower plane realizing on their holdings. Producers gradually regain confidence after a commercial shock, and increase their output wherever the demand permits, while merchants slowly extend their operations and increase their stock-in-trade, and consumers at large begin to add to their consumption. This course of affairs progresses with the gentle ascents and small downward jogs which can well be shown by an ideal graphic chart. This generalization is not local to any one country or community, but must take into account reciprocal foreign influences, which become more potent year by year as international monetary and commercial relations become more closely interwoven.

The last ascent, reaching up to the maximum "boom" point, is usually steeper than the earlier ones. When the decline begins, it may for a short time be gradual, but soon it becomes precipitous, though with small upward reactions in the speculative world, caused by the covering of shorts in the stock market and by corresponding actions in other business, and also by spasmodic investments prompted by the belief that bottom has been touched. Then there is a long pause, a slow readjustment of values, and a virtual repetition of commercial history. Although speculation is here mentioned, the statement concerning it is made in a general sense. Nothing in it collides with the law of supply and demand, or with the volume of production or widening of markets. The natural law continues to operate, while the temper of the commercial world at any given time, the prevalent feeling and opinion as to the immediate outlook, are both affected by the natural adjustments, and, on the other hand, tend to stimulate or depress production and demand. Men, after all, are somewhat like sheep. Their ovine instinct is irrepressible. It takes a very slight impulse to set the flock in motion—savings-bank depositors, tradesmen, consumers, producers, legislators, even the coolest-headed financiers. All are alike in kind, if not in degree. The apparent exceptions prove the rule. Indeed when the general temper becomes nervous and susceptible to alarms, and the public is evidently on the verge of a panic, those who do keep their wits, realizing that a stampede is imminent, take precautionary measures, and thus hasten and precipitate the crash which they would not of their own motion cause, but which they are powerless to avert. This is seen at the beginning of every run on a bank. Men who believe in the stability of the bank and the ultimate safety of their money may not be afraid of the bank, but of the crowd of impulsive small depositors. They therefore get out ahead of the rush, in order to avoid being tied up. This makes matters worse.

There is a saying that panics are to be expected about once every twenty years in this country. The dates 1837, 1857, 1873, 1893 seem to bear out this belief, and in turn the belief reacts on all business. A speculator, a corporation, anyone, would be pretty safe in shaping his general policy by some such rule. This recurrence is a phenomenon comparable in the regularity of its working with the statistics of suicide and crime. It seems to require just about this length of time for public opinion in commercial matters to swing through a certain cycle—from dullness to slow access of activity; to brisk trade, larger production and consumption, fair prices; to implicit faith that good times are to last indefinitely; to extension of credits; to the boom pitch; then hesitation, mistrust, contraction; a sudden loss of all confidence, and a slump in all values corresponding with this unreasoning state of mind. Public opinion cannot be regarded quite as though it were individual opinion on a large scale, for the commercial public of any time is made up of units different from those of an epoch twenty years earlier. If it does not learn by experience, on the other hand it forgets; its memory is hardly capable of reaching back so far. Besides the concrete causes of panics or of revivals, this human weakness cannot be ignored.

The proximate causes of panics, the only ones which superficial observation discovers, are too various and too contradictory to be the real ones. Inflation and reaction in 1893; residual effects of the Baring-Argentine collapse; tight money market; fears of pro-silver and low-tariff legislation in 1893,—these are but incidents, excuses. The true cause lies deeper. It is in the great economic law working mechanically, and incidentally effecting psychologic events.

The next generation may look out for a panic about 1913. In the interim there will be serious backsets, but on the whole the course of business should be progressively better.

THE RAILROAD OF THE FUTURE.

By Theodore Voorhees.

As we ride in the well-appointed train of to-day, over the smooth track, and consider the various appliances that minister to the comfort of our journey, it is difficult to recall the railroad as it was but thirty years ago, so great and numerous have been the changes.

Thirty years ago our railroads were laid with light iron rails on a track ill-ballasted with ashes or gravel ; of sub-drainage one hardly ever heard, and even the ditches were but poor and usually choked with *débris* and weeds. The rails were connected by a short chair of cast iron, which seldom remained firm over twenty-four hours at a time. The passage of the wheels over these loose joints caused the "click-y-ti-click," or song of the train, which was then the invariable accompaniment of a journey. The train that passed over this track would to-day seem well-nigh as crude. The locomotive resplendent in bright brass and paint was, it is true, more attractive to the eye than its successor. But in power how inferior ! It usually burned wood, and it always threw sparks, to the detriment, not only of the passengers' eyes and clothing, but of the passing fences and fields as well. Then the cars : light, low, uncomfortable ; with small windows and no ventilation ; heated in most cases by cast-iron stoves that burned wood, and that were usually red-hot. The passengers suffered torture from the hot air about their heads and the cold draughts about their feet. These cars were coupled by a link and pins, so that stopping or starting the train violently jolted every one in it. Air-brakes were not known. If the engineer had cause to anticipate danger, which was not infrequent, he "blew for brakes," which signal caused the trainmen to dash wildly to the platforms, and at the same time thoroughly alarmed all the passengers.

The first sleeping-cars were beginning to be talked about as a novelty ; as for parlor-cars, there were scarcely any in use. Perhaps nothing more clearly emphasizes the difference in the comfort in travel between the present day and thirty years ago than the entire disappearance of the American duster. In those days no one thought of undertaking a journey without that useful but unsightly garment. To-day one can hardly be found for sale.

Turning from that picture to the present, let us briefly consider a few of the changes we have seen during the past thirty years. First, as to track. In place of the light iron rail poorly fastened, we have to-day substantial steel rails of eighty, ninety, or one hundred pounds' weight to the yard. These are so secured to the ties and to one another that the roadbed affords a smooth and unyielding track for the heaviest trains. The roadbed itself is in most cases thoroughly drained and ballasted with broken stone, is well policed, and presents a neat and attractive sight to the travelers. Next, the trains. It would seem as though ingenuity had been exhausted in providing for the comfort and convenience of the passenger. We now have ample space to sit or move about ; comfortable sleeping-cars, with absolute privacy for every purpose ; dining-cars, observation-cars, reading-rooms ; every appointment, in fact, of a first-class hotel, upon wheels. Then of special cars for special purposes there is no end. Mail-cars of different styles and plans, each suited to its particular use ; hunting-cars for sportsmen ; tourist sleeping-cars ; and even funeral-cars, arranged expressly for funeral parties and used for no other purpose.

Nor has all the improvement been in the passenger service. Equal and possibly even greater advances have been made in the movement of freight. Thirty years ago many roads were distinct and independent of each other, and joined, if at all, with their connections by inconvenient means. Many lines that are now through-routes under a single management were disjointed, and required awkward transfers at terminal points. The journey between New York and Washington involved a tedious transfer by horse-car both in Philadelphia and Baltimore. A similar state of things existed as to freight. Many roads would not permit their freight-cars to go beyond their own lines, so that all freight destined to points beyond had to be transferred from car to car at the junction, involving delay and often damage. To-day this is well-nigh unknown. Passengers and freight are taken across the continent, or from north to south, without the necessity of change or break of bulk.

While these improvements have been taking place in the character of our tracks and trains, the safety of the service has also greatly improved. Perhaps nothing has done so much for this as the invention of the air-brake, for which, and for whose present perfection, the public owes so much to Mr. George Westinghouse, Jr. A train that in the old days of hand-brakes would often run half a mile before it could be stopped can now be stopped inside of its own length. Next to the air-brake, as a safety appliance, should be mentioned the block system. This, in various forms, is rapidly coming into use to-day, and, wherever used, it amply repays its cost in the immunity from accident which follows.

It is but a little over sixty years since the first railway was built in America. It is within the active lifetime of many men engaged in railway service to-day that the changes briefly sketched above have taken place. What will our railway be when it shall have completed its first century of life? What changes will the next generation see? No doubt the railway of to-day will seem as poor to our children as that of our boyhood does to us.

He would be a brave man who would venture to describe the railway of the twentieth century. But one may venture some suggestions as to the needs of the present, and in this way perhaps form an opinion as to the possibilities of the future. Let us consider, first, the roadbed and permanent way. As already stated, great improvements have been made in this respect during the past few years. At the same time we are still using the wooden tie and wrought-iron spike, practically the same as those used thirty years ago. Too much dependence, in the writer's opinion, seems to be placed on the weight and stiffness of the rail, and not sufficient attention paid to the fastening of the rail to the ties. Accidents due to this defect are not unknown even on well-managed railways. It is true, various companies are experimenting with steel ties and with clamps, bolts, and other fastenings to remedy this evil, but so far none can be said to command entire approval. No doubt the end will soon be accomplished, and before many years the wooden tie and short spike will disappear from our tracks. It goes without saying that, in the construction of the railway of the future, wooden structures, such as culverts, trestles, and bridges, will not be permitted. Openings of any sort in the surface of the roadbed ought not to exist. In this connection one improvement, already coming into quite extensive use, may be mentioned: the floor of all bridges, large or small, through or deck, should be solid and so arranged as to permit the deposit upon it of the usual ballast and track. Great safety, both to bridge and train, ensues from such a construction in case of possible derailment.

Grade-crossings must be abolished! When our railways were first built, and in fact in many cases where they have been but recently built, little attention was paid to the question of grade-crossings. The whole aim has been to build expeditiously and cheaply, so that the transportation of passengers and freight may begin, often leaving the real construction to be paid for out of future earnings.

The roads, in turn, have stimulated the building of towns along their lines. Many places that were green fields adjacent to the railways are now populous towns and cities. The inhabitants have built dwellings, stores, and factories immediately fronting on the railway, so that the original right of way oftentimes becomes a public street, intersected by numerous crossings. This process can be seen in almost every considerable town in the country. It is still going on in every direction. With the growth of population follows an increase of traffic. This in turn increases the dangers of the grade-crossing. Then a struggle ensues between the public, demanding safety and the abolition of all crossings at grade, and the railway companies, whose roads in many cases were the origin of the growth of the locality, and whose revenues will not warrant the total reconstruction usually required to remedy the evil.

The present rapid multiplication of trolley-lines is increasing greatly the dangers of the grade-crossing. Competition with steam-lines for suburban traffic is so keen that the trolley-lines run at high rates of speed. In consequence, accidents through failure to properly control the cars at crossings are not infrequent, and this lack of control may be said to have distinctly increased the danger to the public from all such crossings. Municipalities are very generally recognizing these facts, and in many directions plans are taking shape looking to the total abolition of all crossings at grade. Of almost equal importance are the arrangement and construction of the stations. They should be so planned as to make it unnecessary for any passenger to walk upon or across the tracks. The American public is self-reliant, accustomed to taking care of itself, and invariably rebellious against the introduction of gates, fences, foot-bridges, or tunnels intended for the safety of passengers. But at the same time it demands high speed, safety, and punctuality, and it must in time conform to such wise regulations and arrangements as will insure the passage of all trains without the possibility of loss of life or limb.

Another problem for the future will be the abolition of grade-crossings of one road with another, or of branch lines connecting with a main stem. The difficulties presented by this problem will often be harder to overcome than those presented by the highway crossing. The cost, too, will fall wholly on the corporations. The risk is there, however, and ultimately the difficulties and cost must be met.

That our roads should be equipped with absolutely reliable signaling apparatus is acknowledged by all to-day. That this, as well as the proper interlocking of all switches, will be universally realized in future there can be no doubt. With a railroad thus equipped, it will be possible to start a train at speed at one terminus and not slacken or reduce speed until the end of the trip. It may be urged that this is done on many lines to-day. True, but it is in no case done without a certain risk. It often involves considerable risk, not perhaps to the passengers in the train, but certainly to the public on highway crossings and to trespassers and others on the tracks. But what of our trains? Have we reached the limit of improvement? Compared with what they were thirty years ago, the advance seems marvelous.

Will this continue? It is difficult to reply, and yet the writer believes that increasing efficiency and progress will be made in this direction as in others. The public demands high speed. A continuous speed of a mile each minute is no longer unusual. Why should not this be excelled in future? An engine is running to-day that has moved a train a mile in thirty-six seconds,—a rate of one hundred miles an hour. With improved track, no obstructions, no possibility of collision, and an alignment free from sharp curves, one hundred miles an hour ought to be as easy of accomplishment as sixty is to-day. At such high speed the resistance of the air, especially in case of storm or head wind, will no doubt be the chief obstacle to overcome. Very possibly the railway train of the future will be planned with this in view. The lines of the train will be calculated for wind resistance very much as those of a yacht are to-day for the resistance of the sea.

When one considers the wonderful growth in the use of electricity during the past thirty years, it is impossible to say to what uses we may put it in the near future. The electric light and the telephone are familiar in every village. The trolley car is rapidly extending its journeys so that soon it will pass each farmer's door. The steam railways are in some cases lighting their cars with incandescent lamps. Electricity is used for heating cars. At Baltimore an electric plant is rapidly approaching completion that is to provide power for an electric motor of sufficient capacity to move heavy trains through a tunnel half a mile in length. If this can be accomplished, may we not expect to see electricity ultimately supersede steam as the motive power of the locomotive? It will not do to declare it impossible; and yet it is very questionable if it will come in the near future. Electric lighting of passenger trains will doubtless come into general use as soon as a practical and reliable method is devised of generating the power from the axle of the car-truck. But the expense involved in generating electricity in quantities sufficient to exercise a power equal to that of a first-class locomotive is so great that its use is at present impracticable. Possibly the future may develop some plan of drawing power directly from the rays of the sun. If, then, this power can be transferred into electricity and stored, there will ensue a revolution as great as when Watt first discovered steam. Then power will be limited, not by the cost and production of coal, but by the number of days of sunshine each year, and transportation will be brought within the means of all.

We have seen great changes in the construction of our railways, wonderful improvements in the building of our trains, increased speed, increased comfort, greater safety. We confidently look for this to continue until the railway of the next thirty years shall bear the same relation to that of to-day as ours does to that of our fathers. In the same way, what may be called the "Science of Railroading" has developed and improved, and is developing and improving day by day and year by year.

Thirty years ago rule-of-thumb methods prevailed. Each manager was a law unto himself, and his road was managed pretty much as he saw fit. The times developed strong men, and they made their mark upon the roads with which they were connected. But oftentimes their marks were strange, and their rule, though strong, was far from economical. Uniformity of practice was quite unknown. No two roads had the same rules. The commonest signals were interpreted differently on connecting roads, and often on different divisions of the same road.

This has been almost entirely changed. The American Railway Association, which comprises in its membership the great majority of the railways of the country, has for years devoted its labor and influence to this cause. It is owing to its efforts that we to-day have uniform time over all portions of the country. The accomplishment of this object was a task that took years of labor, and was ultimately successful in spite of most discouraging opposition. Next was brought about a system of uniform train rules and signals, and rules for telegraphic train orders. At present the Association, through its committees and by discussion at its semi-annual meetings, has under consideration methods of block signaling and rules governing the same; safety appliances; and the question of uniform rules and regulations governing employees. Owing to the influence of this Association very great improvements have been brought about all over the country in uniformity and simplicity of management, with resulting increased safety and economy.

In one respect, however, the science of railroading to-day has distinctly retrograded as compared with a period of ten or fifteen years ago,—namely, in the use of freight-car equipment. There are probably not far short of twelve hundred thousand freight-cars in existence in this country. It is safe to assert that there are at least twenty per cent. more than the business of the country requires, or than would be sufficient to move all existing traffic. Moreover, this equipment is so badly handled that each car, on an average, is in motion only one hour in each twenty-four, and the average daily mileage made by each car is no greater, perhaps less, than ten or fifteen years ago. It is true, the last ten years have seen the very general establishment of car-service bureaus all over the United States. By means of these agencies, and through their influence, the old evil of using freight-cars as storehouses has very greatly disappeared. But, while the consignees and the public generally have learned that freight must be removed promptly and that cars must not be held indefinitely, the railroad companies have not been equally prompt in moving the cars thus emptied and released; foreign cars especially are not promptly moved; and, as a consequence, the general movement is sluggish. To look for the causes of this state of affairs and endeavor to point out the remedy would involve a discussion too technical in terms and foreign to the scope of this paper. Suffice it that the subject is of such grave importance that it has been recently a topic of discussion at a largely-attended meeting of high railway officials, and by them referred to the American Railway Association with a request that that body give it careful consideration, and, if possible, report a plan that will afford relief. That this will be accomplished the writer has no doubt, and, when done, it will be by no means among the least of the many improvements characterizing the railway of the future.

Among its most important developments will be the improved relations between the employees and the companies. In spite of numerous strikes, and much ill-feeling on both sides, there is to-day a much better feeling between the men and the corporations than existed thirty years ago. The old arbitrary methods and domineering rule have in most cases disappeared. Injustice and favoritism, once only too common, are to-day but seldom seen. Still much remains to be accomplished. The rapid increase of the trades-union idea among different classes of railway employees has been a marked feature of the past ten years. Encouraged by the success of the Brotherhood of Locomotive Engineers, the other classes of employees have organized like unions. The engineers have achieved their present position through much suffering and the hard lessons of defeat. The other unions are going through a like process. Influenced often by hot-headed and rash leaders, with but little or no consideration they have made unreasonable demands, and precipitated strikes that have resulted disastrously,—to them most of all. The great strike of last summer was the most unreasoning and most disastrous. But the end is not yet. Very many of the men and some of the leaders have been made to believe that wages can be regulated by legislation, and that laws can be devised that will bind the corporations, but leave the men free to come or go at their pleasure. These and similar fallacies must be thrashed out by actual test before the unions will be convinced. That the great majority of unions existing to-day among railway employees will change their methods and aims within the next thirty years the writer does not doubt. This will not be brought about without struggles and trials of strength. In time these unions will learn their proper place in society, and will be respected accordingly. They will learn to use their strength not tyrannically, but moderately, for the real benefit of their members. Their agreements will be of value because they will be adhered to. Strong in their own rights, they will recognize the rights of others, and not attempt to extend their control beyond natural limits, deprive non-union men of the privilege of working as *they* see fit, or the officers of the companies of the proper exercise of *their* powers.

When this time comes, the unions should be encouraged by the companies, and the employees advised to join them. Meanwhile and thereafter the true rule that should govern in all dealings between the officers and the men is "do as you would be done by." "Be absolutely just and impartial, enforce strict discipline, and meet all complaints with patience and good temper." By such a course we will remove much present friction and hasten all the more the completion of our Railway of the Future.

THE SELECTION OF MOTIVE POWER.

(SECOND PAPER.)

By Charles E. Emery, Ph.D.

ANOTHER type of moderate-speed engine has been developed, in which the details of high-speed engines are used, thereby securing a somewhat simpler engine, some forms of which are also economical.

The accompanying table shows approximately the cost of steam-power under conditions differing as to the amount of power required and the type of engine employed. The calculations are based upon the average results obtained in practice rather than those shown under merely experimental conditions. The cost of coal at three dollars per ton is derived from conservative but fair values of the water per indicated horse-power per hour as well as the evaporation per pound of coal for the several engines and powers stated in columns 2 and 3. On such basis the coal per indicated horse-power per hour varies from 5.6 pounds for the small simple engine to 1.65 pounds for the triple compound engine, whereas experimentally an indicated horse-power should, with an engine of the kind last named, be obtained for less than 1⅓ pounds of coal. The conservative quantities mentioned are increased to allow for ten per cent. friction between the horse-power in the cylinders and that delivered at high speed to a jack-shaft or equivalent; and, in addition, ten per cent. is allowed for the various wastes incident to starting and stopping fires, so that the hourly cost of coal in column 4 is higher than would be determined by a mere theoretical discussion, though believed to be fairly correct for the conditions of average practice. The costs given for labor, supplies, and repairs in columns 5 and 6 have been derived from such costs under actual practical conditions. In columns 7 and 8 it is assumed that the cost, under average conditions, for taxes, insurance, and a contribution to a sinking-fund to provide for renewals, is five per cent. of the estimated total cost of the machinery in place, including foundations, buildings, and chimney; in addition to which in column 7 five per cent. is added for interest on first cost, or dividends on stock representing the same, and in column 8 an alternative charge of ten per cent. for the same purpose. The latter is believed not to be too high for the ordinary work of stock companies, as the company would in general endeavor to raise the actual cost on bonds upon which interest must be paid, and expect to pay, in addition, a dividend on stock of a like amount. Columns 10 and 11 show the total cost in cents per net horse-power per hour, the former being on the basis of five per cent. interest, and the latter on the basis of ten per cent. Columns 12 and 13 show these quantities so extended as to exhibit the corresponding costs per horse-power per year. A study of the table shows clearly that the cost of the power decreases rapidly as the power increases, independent of the cost of coal, which is decreased by the use of more economical engines. The cost of labor largely influences the result first stated, although for the smaller engine only part of the services of one man has been charged. For the larger engine the interest has a much larger influence than is generally considered. Considerably lower costs are frequently given, for the reason that a less conservative and practical basis is employed to ascertain the cost of the coal ; and, moreover, many of the items of cost herein stated are frequently omitted entirely, though all have an important influence on the final result. For more elaborate investigations on this subject more extended tables prepared by the writer may be consulted.* It should be borne in mind, however, that all tables are necessarily based on assumed conditions, and therefore only show approximately the results to be expected in a particular case.

It is possible to locate some branches of manufacture where means for supplying power have been already established. This may be water-power direct, or it may be water-power transmitted to a city electrically, as proposed in connection with Niagara Falls, or a steam supply from a street system, or even a supply of power by belt in a building. For each of these cases the above table on the cost of steam-power gives a fair idea of what the manufacturer can afford to pay. If the location for the manufactory to be operated by water-power is between two canals of different elevations, and the manufacturer must put in his own canals, wheel-pits, and races, the cost of these should be considered in connection with the rental. If electricity is furnished, but not a motor, this cost and the consequent connections must be considered. These illustrations are sufficient to show the principle, but the question of reliability of supply, the certainty of doing work every day and hour in the year that it is required, must be considered in connection with the various other questions, such as adaptability of location, contiguity to markets, and rates of transportation.

The value of a water-power depends in general upon the reliability of the supply. A torrential stream running only at times during the fall, winter, and early spring is, however, available for power purposes under certain conditions, if the cost of the plant can be kept down so that the question of interest is not of a serious character. Along such a

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*See Trans. of the Am. Soc. C. E., Vol. XII., November, 1883. See also Trans. Am. Inst. El. Eng'rs., Vol. IX., March, 1893.

COST OF STEAM-POWER.

1	2	3	4	5	6	7	8	9	10	11	12	13
			Cost per Net Horse-Power.									
	Kind of Engine	Net Horse Power.	Per Hour for Coal at $3.00 per ton.*	Per Hour for Labor.	Per Hour for Supplies and Repairs.	Per Hour for Sinking Fund, Taxes and Insurance; 5% of total cost added to.		Per Hour for Coal, Labor, and Supplies.	Total per Hour.		Total per Year of 3080 Hours.	
						5% Interest and Dividends.	10% Interest and Dividends.		For 5% Interest.	For 10% Interest	For 5% Interest.	For 10%. Interest
			Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Dollars.	Dollars.
A	Ordinary Non-Condensing	10	.9705	1.00	.28	.1948	.2921	2.25	2.45	2.54	$75.46	$78.31
B	Automatic Cut-off Non-Condensing	75	.5556	.37	.19	.2110	.3165	1.11	1.33	1.43	40.96	44.04
C	Automatic Cut-off Condensing	150	.4239	.25	.14	.1948	.2921	.814	1.01	1.11	31.11	34.19
D	Compound Condensing	250	.3465	.17	.09	.2078	.3117	.607	.815	.919	25.18	28.40
E	Triple Compound Condensing	500	.2697	.11	.08	.2338	.3507	.460	.694	.811	21.38	25.06

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* As stated in the text, the coal per hour has been calculated on a conservative basis designed to represent average practice rather than the results possible with apparatus in perfect condition. The basis is 42 pounds of feed water per H.P. per hour for line A, 28 lbs. for line B, 22 lbs. for line C, 18 lbs. for line D, and 14 lbs. for line E, and evaporations per pound of coal of 7½ pounds for line A, 8.25 lbs for line B, and 8.5 lbs for the remaining lines. With engines of the kind stated, proportioned for the work and in good condition, the water consumption should be 2 pounds less for each engine, and an evaporation of 9 pounds of water or better per pound of coal could frequently be obtained. As the costs are generally stated for the indicated horse-power, it should be noted that a friction of 10% has been assumed to cover losses not only in the engine, but due to transmission to a jack shaft. For engines running 24 hours per day, the allowance of 10% of the fuel for starting and stopping fires should be decreased. Engines generally keep up their economy for long periods, but the amount of coal is frequently increased by carelessness in connection with the selection of the fuel, the firing, care of boilers, &c.; so, even if the engines require 2 pounds less water than assumed, the coal required generally costs fully as much as stated.

stream the farmer's boys can get in their harvests in the dry season, get out and haul logs in the winter before the snow melts, and saw them by the water power when the stream is full. In such case the labor having other occupation is never idle, and a condition of things is possible which is impracticable under regular manufacturing conditions. The same condition of things can obtain on a small stream with a large mill-pond, if the miller has a farm or work-bench to occupy his time while the mill-pond is filling up, the conditions being somewhat the same as for a windmill.

To determine the conditions under which water-power is more advantageous than steam power, it is necessary to establish a basis of comparison. From considerations above stated it will be seen that the cost of steam-power depends in part on the price of the fuel at the particular location, and in part on the cost of the maintenance and repair of the machinery required to produce the power, together with interest and dividends on the capital represented by the first cost of the plant. The cost of water-power is represented by the interest on the cost of dams, canals, races, wheels, and means of transmission, together with the cost of maintenance and repair, but in addition, for most locations, contingent allowances must be made for damages from floods and ice and loss of profits from stoppages due to lack of water, injury to plant, &c. In most factories where power is derived from water, steam is also a necessity,—at least for heat and various manufacturing purposes,—and it is well known that the best way to utilize the power for variable streams is to provide duplicate plants for water and steam, in which case the saving due to the water-power is represented chiefly by the cost of the fuel saved, and this is partly offset by the increased interest and maintenance charges due to the double plant. It will thus be seen that the mere fact that water from an elevated source is going to waste in large quantities does not necessarily mean that the power thereof can be utilized economically in comparison with power derived from a steam-engine. A solution of the problem can only be obtained for each particular case. For illustration, we present a comparison we made some time ago in relation to the cost of water-power on the Merrimack River.*

In that case the property at particular points had been developed by companies at a cost of at least $77 per horse-power, and the lessees of the power had put in head gates, flumes, wheel-pits, wheels, and tail races at a cost of $45 per horse-power of wheels, or about $65 for each horse-power utilized on the average throughout the year,—making a total cost of $142 per horse-power. "If we consider that accidents are liable to happen to the best-constructed hydraulic work, we should charge at least 2½% of the original cost for depreciation, say 1¼% for repairs, and about 1¼% for taxes, or about 5% independent of interest account. If, then, on the principles above developed, we charge 10% to an account for interest and dividends and allow 2% for operating expenses, the total annual charge becomes 17% of the original expenditure." Seventeen per cent. of $142 is $24.14, on which basis the cost of water-power appears to be about the same as the cost of steam-power with the most economical engine shown in the above table. The cost of coal on the Merrimack River, however, is greater than three dollars per ton ; so, on the basis discussed, steam-power appears to be cheaper, and this conclusion is further emphasized by the fact that steam is required for other purposes in all the mills, and that heating, boiling, &c., can be done efficiently with exhaust-steam. The power from engines furnishing exhaust-steam is obtained at a nominal cost, as the heat in the exhaust-steam can be charged to another account and amounts to about eighty-five per cent. of that taken from the boiler. From these considerations it would appear that there would now be no object in establishing cotton mills along the Merrimack, for mills built on the seaboard would have a decided advantage in the price of coal and in the transportation of raw materials and finished products. In a general sense the comparison is correct, for steam-mills in Fall River do compete in the market with those having water-power in that place and on the Merrimack. A more recent investigation of the subject developed, however, many reasons why the water-powers on the Merrimack will never be abandoned, and some reasons even for rebuilding the same if destroyed. Although the water-power is owned by a separate company at each place, the principal stockholders are the companies owning the mills. In most cases the business of furnishing the water has been very remunerative on account of original purchases of land upon which now stand large portions of cities. Moreover, with such an organization, the surplus profits paid for water-power to the power company are really returned to the mill-owners. It follows, therefore, that, if we consider the actual results by eliminating the independent company, the mill-owners obtain their water-power under quite advantageous conditions. Practically the cost to them is simply that of maintenance. The dam, canals, and permanent struuctures were well built in the first place, and very little is required for keeping them in order. The same is true of the sub-canals, wheel-pits, and races at the several mills. The greatest item of cost is the renewal of the wheels themselves ; so the cost to the mill-owners in such a location is practically this last item, plus the cost of maintenance of permanent work, together with interest on an investment which itself pays a dividend and therefore pays such interest. Moreover, the rate of interest assumed is too large, if the property be considered as practically owned by one association. So also, for reasons stated, the large rate of depreciation named above should only apply to structures that wear out rapidly, like the wheels and gates. Such a modification of the items of interest and depreciation greatly reduces the cost of the power to mill-owners. To determine an exact balance for a particular location would require an accurate knowledge of facts not entirely available, and the details in any case could not be discussed in this article, which is necessarily confined in the main to general principles.

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*See supplement of article in Trans. Inst. El. Eng'rs. previously referred to.

From the above considerations it will be seen that an old established water-power may be more valuable than a new one, for the reason that the stability of the permanent structures has been established by time, and a low rate of depreciation may be fixed by experience. No new company could build a large plant without providing for the various items of cost given above. If collateral profits are expected to meet the interest, they should be considered ; and, if the work is well done, as it should be in every case, the rate for renewals stated above is too high for a long period of years, but for safety should be considered for a reasonable time to provide for an unexpected contingency. The safest way would be to put a definite percentage of the original cost of the plant each year in a sinking-fund, and, when the sinking fund becomes large enough to pay for renewal of structures most likely to be destroyed by accident, it should be stopped, but kept at interest as an asset. Meanwhile a very low rate of depreciation can be charged against the remainder of the plant, so that the condition of the books is always on the safe side. It will be seen, therefore, that there are some important financial questions to be considered, and that a water-power available for a long time may have a very great value, even when compared with steam-engines under modern conditions. In deciding the questions for a particular case, a special investigation must be made, taking all considerations into account. There are locations where water-power may be developed so cheaply that the principal question is to ascertain if it can be utilized. The answer, independent of the question of establishing a new city, largely depends upon the availability of proper means to transmit the power to cities and manufacturing establishments at a distance, or to points near mineral deposits, where power is desired. Wire-rope transmissions are available for distances of a few miles, though generally limited to a few thousand feet. Air-transmission is desirable for mining purposes, as the air discharged from the working cylinders assists in the ventilation of the mines. There are also some large installations in which air is used to transmit power several miles. The air is compressed with powerful pumps, becoming thereby heated to such an extent that it must be cooled artificially. This cooling represents a loss of energy, to which must be added the loss due to friction in the pipes and the losses due to the engine operated by the air. For these reasons the efficiency of air-transmission is generally considered to be only fifty per cent. for short distances, and is generally less as the distance and number of points of supply are increased. Compressed air is used commercially in Paris on the Popp system, and Prof. Riedler has shown that the efficiency is materially increased by the use of reheaters, which to a greater or less extent restore the heat lost in compression, and thereby make the air operate more efficiently. Of late electrical transmission has come to the front, having been made practicable by the use of alternating electric currents of high tension.

Great interest was excited in this subject by the transmission of upward of a hundred horse-power a distance of one hundred and eight miles from Lauffen to Frankfort during the Electrical Exhibition at the latter place in 1891. The transmission was obtained with an efficiency of about seventy-five per cent. from the power delivered by the water-wheel at one end to that delivered by the electric motor at the other. The resulting loss of twenty-five per cent. therefore included the losses in the generator and the motor, the line losses, and those due to step-up transformers at the transmitting end and step-down transformers at the receiving end ; so the result, independent of capacity, was electrically and mechanically a great success. Further developments were checked for a time on account of the comparatively large cost of that installation, particularly in relation to the capacity actually obtained. Since then, however, the subject has been taken up by the principal electric companies here and abroad, and the cost of the work brought down to comparatively reasonable limits, so that under its early advisers the Cataract Construction Company apparently expected to be able to transmit and sell power in Buffalo for something like one-half the cost of steam-power. Later developments, and perhaps the advice of the writer and others, called attention to the many features to be considered in developing such a problem, and as a result prices have been materially increased. There is no question but what water-power may be obtained very economically under the conditions obtaining at Niagara Falls, and should be sold at very reasonable rates on the property of the Company. The question just how far it will be practicable to transmit the power electrically at a profit to the company and with advantage to the consumer must be developed on a commercial basis of bargain and sale, the same as dealings in any more tangible commodity with the delays incident to such transactions.

No such questions arise in the mining regions of the West where coal is high-priced. Quite a number of installations have been made in such localities, which are operating satisfactorily between points separated by considerable distances. Some water-powers have also been developed at the East in the vicinity of cities, one notably at Sewall's Falls on the Merrimack, near the city of Concord, N. H., where tri-phase alternating-current electric generators at the Falls furnish corresponding electric currents which are distributed in the city for lighting and power purposes. The results of all the applications, though encouraging, are not yet sufficient to warrant the early realization of the dreams of the sanguine that ere long all the cities of the country will be supplied with power, light, and heat by electrical transmission from waterfalls and coal-mines, but progress is being made rapidly, and developments as wonderful as those already achieved in the past may be reasonably expected in the future.

MUNICIPAL CLEANSING AND PUBLIC HEALTH.

By Geo. E. Waring, Jr.

IT is not yet known exactly *how* the accumulation of filth in a town favors epidemics of disease, nor is it necessary to discuss this here; for, while there are numerous examples of long-continued immunity from disease amid most filthy surroundings, there are records of a great many fatal outbreaks by which communities so situated have been suddenly devastated.

There is an almost unbroken record of the final disappearance of oft-recurring epidemics and a steady improvement of the public health following the draining and cleansing of filthy towns and the supply of good water.

It is usual to measure the health of a community by the *death-rate*. The true measure would be the *health-rate*. There may be a vast amount of sickness, and of costly disability, with a very low death-rate; but a high health-rate is an unfailing index of good sanitary conditions, and it ensures a low death-rate as a matter of course. It is probably safe always to say that, while man may so far withstand the influence of filth as not to *die* from its effect, the public *health*—the vigor, efficiency, comfort, and happiness of the people—is likely to be grievously lowered by it.

It is a fundamental principle of municipal economy that what leads to health leads to wealth. Yet there is no other self-evident proposition to which public sentiment is so indifferent. Nothing is easier than to awaken popular interest in a new city hall, a brick pavement, or a new fire-engine house, and nothing is more difficult than to raise it to the paying point in favor of good drainage, clean streets, and enforced sanitary regulations. It often requires the stimulus of a fatal epidemic—a sharp, quick, and repeated stroke of death—to loosen the public purse-strings in the interest of the public health. Sometimes even this is of little avail, and we have to await the influence of a great popular panic of dread, as of cholera or yellow fever. The cholera scare of 1892, when one enthusiastic newspaper doctor said: "The cholera germ is actually thundering at the gates of New York," did more good to the crowded tenement-house districts of that filth-ridden city in a few weeks than had been accomplished during years of indifference. The first case of yellow fever at Brunswick in 1893 frightened its people to flight, and instituted a heartless "shot-gun quarantine" throughout the whole region into which they fled. During the whole season there were fewer than sixty deaths, and most of these were believed by experts to have resulted from the perennial "malarial fever," which is always very fatal along that coast. As a result, Brunswick is now being sewered in the most effective way, and sanitary regulations are being enforced which, with the improved drainage, will save more lives every year than have been lost through yellow fever in any ten years, to say nothing of the reduction of sickness from minor malarial diseases, which have constantly sapped the vigor of the people.

The dread of yellow fever is not unnatural, for its devastations in Boston, New London, New Haven, New York, Philadelphia, and most of the larger Southern cities have been terrific. The improvement of health conditions seems now to have driven it into the south-eastern corner of the country. Memphis was reclaimed after its very fatal epidemic of 1878–9. New Orleans was first fenced in by a quarantine, which has at least coincided with immunity from yellow fever, and it is now being sewered.

It is safe to say that there are more deaths in the United States every year from distinctly "preventable" diseases, which are always with us, than have been caused by yellow fever and cholera together in all the thirty years since the war. Yet we take these deaths as a matter of course, and we pay no official regard to the twenty cases of disabling and painful illness that each death is estimated to represent.

Let us take, as a concrete example, the case of a town that has only twelve deaths from typhoid fever in a year. This disease can be entirely extinguished. Every death from it is an unnecessary death,—as much so as a death from small-pox. The town in question therefore suffers, monthly, the private execution of one of its unoffending citizens, in expiation of a crime that may be partly its own and partly its neighbors. The people accept this execution as calmly as they would accept a monthly death from old age. They go on electing the usual city officials and voting money liberally for pavements and new fire apparatus ; but they leave the care of the public health to agencies that were considered adequate at a time when we still supposed that the question of life and death was in the hands of God, and was to be determined largely by prayer. We now know that in this case, as in so many others, "laborare est orare" ; but, while we may trust less to prayer than we formerly did, we are still slow in effective labor.

While great advances have been made in sanitary knowledge and practice in a few towns and among a limited class of the people, when we come to consider the 12,000,000 inhabitants of towns of more than 1,000 and not more than 25,000 population, we find that, as a rule, sanitary improvement hardly exists. With the great majority of these towns, the beginning of the sanitary impulse, beyond the occasional influence of a striking epidemic, or the fear of an impending epidemic, has hardly yet been felt.

It is to towns of this class that I propose chiefly to address my effort, as the field in which the greatest good may be accomplished, and in which the accomplishment is most needed. Messrs. Collingwood, Haupt, and Hering will enrich this series with information in regard to engineering elements of sanitary work, as applied to the large cities; and what I may have to say as to sanitary regulations is of universal application,—to the village and the metropolis.

The subject divides itself naturally into two sections,—Construction and Administration.

CONSTRUCTION.

The first works called for in sanitary improvement are those intended to get rid of such household and factory wastes as may properly be carried away by water flowing through confined channels. This is the part of sanitary drainage that is called sewerage. It is not necessarily the sewerage practised in the larger cities, where it is, or is supposed to be, a requirement that clean rain-water, as well as foul drain-water, should flow off together in large conduits. It is a much cheaper, simpler, cleaner, and less odorous device. In its best form, it is an outgrowth of, but an advance upon, the " separate " system of England. It is a strictly separate system, to which, beyond the very small amount of water required for flushing, nothing is admitted except certain industrial waters, water-closet matter, sink and laundry wastes, etc.,—nothing, that is, but water which has been fouled in houses and shops, and of which it is necessary to get rid.

This system was first introduced by the writer, at Memphis (1880). It has since come into such general use in all parts of the country, for minor towns, that it bids fair soon to become the universal American system. The engineer of the improved sewerage of Boston, who successfully contested my recommendation that the " Memphis " system should be used there as a basis of improvement, and who was long the most effective partisan of the " combined " system, said, in 1891, in the discussion following Dr. Barnes's paper on sewage disposal, read before the Massachusetts Medical Society, that " it would have been better if Boston had adopted the separate system, as recommended by Colonel Waring."* The sewerage of New Orleans is being carried out on the lines which I laid down in 1880, with a complete exclusion of storm-water.

These facts are stated to give assurance to the reader that, with the possible exception of the larger cities, the question as to the " separate " system or the " combined " system has been definitely settled by sufficiently long and ample experience.

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* Or words to that effect.

In the larger cities storm-water must be carried off underground from points at which it accumulates in such volume as to be seriously objectionable. These points are reached only at considerable distances from the limits of each drainage district, and the outlets from them may be so arranged as to constitute only a modest portion of the whole length of sewers.

These outlets may serve as combined sewers, carrying the outflow of the separate sewers, with which alone the upper portion of each water-shed should be supplied. In support of this opinion it may be said that Baltimore, whose sewers are still mainly the street-gutters, had, in 1880, with two hundred and ninety miles of streets, less than twelve miles of sewers. These were constructed in flooded districts, to carry off accumulations of storm-water. Statistics for 1890 are not yet available, but there has been no change in the principle on which the sewers are built, and their total length is still trifling as compared with the length of streets. It is generally thought that it is only in hilly towns that this limitation of the length of storm-water sewers can be made. This is a mistake. The flatter the inclination,—even to the rate of one to one thousand, if the gutters are at all carefully graded,—the greater the distance to which storm-water may be kept on the surface.

One other consideration should have a great influence over the choice of a system. It is that we are fast nearing the time when the purification of sewage will be made imperative in a great majority of cases. It is also necessary, in many towns, to pump the sewage to a higher outlet. Under both of these conditions rain-water should be rigidly and completely excluded. The system should be " an efficient and well-regulated machine for the speedy and unobjectionable removal of water-borne filth, and its delivery as a substantially uniform product at such a point as is desired, and in a condition capable of treatment in a uniform manner by a uniform plant, whether chemical, mechanical, or otherwise." *

The attempt to admit roof- or yard-water, and to get rid of the surplus by storm overflows, is " a delusion and a snare." It has been found in England that what is there called the separate system—which excludes *street* water—has its flow increased by storms to as much as eleven times.† As the requirement for purification or for pumping increases, the " storm overflow " device will be found to be more and more unsatisfactory.

The drainage of houses is not a public duty, but it is a public duty to require that houses be drained and that the work be properly done.

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* Charles H. Latrobe.

† W. Santo Crimp.

This is the most important part of sanitary drainage, because it is the part by which the people are most influenced. Bad conditions within the confined atmosphere of the house are much more dangerous than bad conditions in the open streets. This fact is easily overlooked, because the ill-effect of imperfect drainage is popularly supposed to be caused by "sewer" gas. Whatever this term may represent, sewer-gas is more often the product of bad plumbing in the house than of bad sewers outside of it. It is always the result of improper arrangement or of bad workmanship, and should never exist in house or town.

The details of house-drainage cannot be considered in this short paper, but they are now well understood, and properly-formulated "regulations" should be established; and they should be enforced with vigor and precision. This is a most important duty of the health authority, not only because of the direct danger to the inmates of each house, but because a badly-drained house may establish a center of infection, and so become a menace to the health of the community. Only competent mechanics should be licensed for house-drainage work, the plans and the workmanship should be subject to competent control, all details should be inspected, and all conduits should be tested—under pressure, for the peppermint test is another snare and delusion. No connection with the sewer should be permitted until the proper officer *knows* that everything is right.

Under the head of construction comes also such regulation of unoccupied areas as is necessary to secure the prompt flowing away of all storm-water that the ground cannot absorb; such regulation of gutters as shall ensure their easy cleansing; such regulation of street surfaces as shall make it possible to sweep them clean; and other details of more or less importance and practicability, according to the size and the wealth of the town.

ADMINISTRATION.

The preservation of the public health depends, after all, much less on construction than on administration. As in good house-keeping, so in good town-keeping, "eternal vigilance" is the price of success. A country house in Holland may have no drain, even from its kitchen, and no water supply save the maid-servant's neck-yoke cans, filled at the canal, but the eye of the mistress is an all-seeing eye, and there is nowhere permitted so much accumulation of wastes as would feed a roach. An American town may be without drains and without waterworks, and still be kept as clean and fresh as Dutch towns invariably are. No town is "self-cleansing"; the process of proper maintenance is not an automatic one. The health officer and his staff can never relax their watchfulness and their activity without an immediate falling-off in cleanliness. The production of garbage, ashes, dust, waste-papers, rubbish, manure, and the manifold offscourings of life and industry, never stops; and their collection and removal must never stop. The only effective—the only economical—way to clean a town is to clean it constantly.

The writer has traveled much, and usually with an eye to sanitary conditions. He has never seen a clean town in the United States, and he knows of none that pretends to have a good scavenger service where a better result could not be obtained, at less cost, by doing the work more in detail and more constantly.

One of our great present difficulties is due to the custom of encumbering the public service with a vast amount of work that should be done by the people themselves. Nothing should be thrown into the streets, or deposited for removal by the public scavengers, that can, even at some cost and inconvenience, be disposed of on the premises where it is produced; nor anything that can be made to pay the cost of its collection and removal,—such as paper, rags, sticks, wine-boxes, flour-barrels, straw, and bottles; nor anything that can be burned—cremated—in the house which desires to be rid of it, or which it would be worth "The Golden Dustman's" while to collect and sell from the public dump.

Above all should the people be prevented from littering the streets with scraps of paper, orange-peel, banana-skins, and other rejectamenta, which they now shed as they walk, in disregard of the fundamental principle that the easiest way to keep clean is not to make foul.

Removal from the streets by the public service should be limited to road-detritus and horse-droppings; and, from the houses, to clean ashes and such refuse as cannot be burned, sold, or given away. The collection of ashes may be so regulated that the ash-barrel shall not stand on public sidewalks; and, in short, by proper attention to details, the whole service of public scavenging may be made much less conspicuous than it now is.

The cost of such service would not be excessive, but, cost what it may, it should be performed. There is no way in which the same money can be made to bring a better return. Neither fine civic architecture nor beautifully-kept parks will give such attractiveness to a town, or incite such a laudable pride among its people, as the perfect cleanliness and orderliness that a proper administration may be made to maintain. Valuable though parks and "breathing spaces" are to the public health, the perfect cleaning of streets, and such cleaning of houses as the health authority may properly enforce, will be even more valuable.

It would make no bad motto for municipal guidance to paraphrase the Scripture injunction and make it read: "First pure, then beautiful."

The work of municipal house-cleaning outlined above ought to come under the control of the health officer, but, if it does, this officer must be a rare sort of man. There are some reasons why he should be a doctor, but they are rather theoretical than practical, and it is rare to find a doctor, qualified for work demanding so much executive ability and so much capacity for labor, whose professional success, or hope of success, does not make him unavailable for an ill-paid municipal office. A doctor who seeks an easy berth, or shelter for his declining years, is not available, for the controlling reason that he is not fit for the place. The health officer should be selected for his general qualities, without regard to his profession, and he should have the aid of the city physician. Even if a physician himself, he should be called on for no professional services, or personal duties of any sort. He will do his best work by making others do his work for him.*

The most important part of the clerical work of his office will be the keeping of vital statistics, the securing reports of cases of contagious and infectious diseases, the recording of the action taken concerning these, the registration of plumbers and drain-layers, the examination of plans proposed for house-drainage, and their approval or disapproval.

The executive work, aside from street-cleaning, scavenging, etc., will cover the control of the execution of such plans, the inspection of nuisances and the supervision of their abatement, the inspection and sanitary control of stables, yards, tenement-houses, market-stalls, etc., and the notification of possible causes of accidental injury to life or limb.

An important and very prevalent obstacle to the carrying out of projects of sanitary improvement is found in the fact that city officials are disinclined to delegate their executive powers. Neither a board of aldermen nor a sanitary committee can do the work under consideration so well as a single officer can. It is eminently a case where the one-man-power can be used to the best advantage, for there must be a fixed determinate policy, as far removed as possible from the uncertainty, compromises, and deviousness of an action that is controlled by several minds. The only committee that is tolerable for executive work is a committee that is controlled by one master mind. It would be better to free the master mind of the need for carrying the dead weight of useless colleagues, and to give it—under properly-established regulations—absolute and unquestioned control of the whole business.

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* This, of course, does not apply to villages or to very small towns.

The health officer should be selected with the greatest care. His functions are of vital importance, and their faithful and wise performance touches the best interests of the whole community. There are few men who are qualified for the duty. One who is qualified should be well paid, well sustained by the mayor and council, and left, as far as possible, free to do his own work in his own way. He should be subject to one restraint, and to one only. He should know that, if he does not perform his duties properly, he will lose his position. So long as he does perform them properly, public sentiment should give him such support that there can be no question of his removal. Public sentiment should always be indulgent and patient with him, for he will be in almost daily conflict with individual citizens of all classes, who have to feel the pressure of his requirements, and his tact will be severely tested.

THE RELATION OF RAILWAYS TO MUNICIPALITIES.

By Dwight Arven Jones.

THE vitality and growth of every city of the present day are inseparably connected with its opportunity of becoming a part of the business and activity which are taking possession of the world. And the most casual investigator will see that with the building of railways in the United States has come a marvelous growth of vigorous municipalities, and that without means of quickly reaching distant points of this continent it would have been impossible to have reached our present development. This, moreover, has been appreciated by the people, as we have progressed. For the national government, in the aid extended to the Pacific railroads, showed its keen appreciation of the importance of opening the country through which the roads passed, and hundreds of municipalities throughout the West, by the issue of bonds, have materially aided in the construction of roads through their particular localities. It was in the early days of the country, however, that this anxiety for new roads was felt, and for many years valuable and often exclusive privileges were conferred upon railroads without a thought of the obligations of the roads themselves. But with the growth of the country, and when the vast power of the railroad systems was appreciated, there came a reactionary movement of much force, and one which has not yet subsided. Municipalities formerly the most ardent suitors have joined in the attack, and now cast avaricious eyes at the treasury of every prosperous road. But has not the time come when it may be asked whether investors have not suffered sufficiently? Whether there should not be a cessation of attacks upon railroads from all conceivable quarters? And whether municipalities in particular—the outgrowth of railroads, and their favorites in respect to rates*—should not be willing to show a just consideration for the rights of the roads? These questions are pressing for answers, and it seems a suitable time to consider some of the reciprocal obligations of railways and municipalities.

And first I shall consider the subject with respect to steam railways. It must be appreciated at the outset that a municipality occupies a dual capacity. On the one hand, it is a branch of the general government, standing as the representative of the State for a particular locality, and, although it does not usurp the power of the State, it nevertheless in many respects is clothed with supreme governmental authority. But, on the other hand, the city also exists as a distinct corporate person. It has its own treasury, its own property wholly distinct from State property, and it possesses a continued personality and history which distinguish it from the State and from all other municipalities. It represents, therefore, both the interests of the State and those of its own particular locality.

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* See article on "American Railways and American Cities," by Henry J. Fletcher, *Atlantic Monthly*, June, 1894.

But it is no part of the duty of municipalities to control railway or any other corporations. The extent of the legislative control of railways does not come within the scope of this paper, but it is well known that this control, as now exercised, has created many complex problems in railroad development, and has put great burdens upon many roads. The one power of regulating rates for service is of paramount importance—and this is a power which the courts have clearly established as a State function. If we add to this the "police power" and the right of taxation which all States possess, it is seen that railroad corporations are more likely to be crushed than to control the country.

Municipalities, however, are not charged with the responsibilities of exercising these powers. They must guard the lives and property of their citizens, and should endeavor to further their own prosperity. But they should never be willing to usurp the prerogatives of the State, or to destroy railway property for municipal benefit, or to impose unfair burdens upon railway corporations. For the progress of every municipality is largely dependent upon the character of its railway service. And the public demands not only a good service, but one that shall continually improve and keep pace with developments in railroad operation. To accomplish this requires large and continuous expenditures by the railways;—facts which a municipality desiring to receive full benefits from its railway connections should not forget. Municipalities should therefore, above everything, avoid a policy of plunder, and should protest against legislation which makes them parties to it. Unfortunately they do not always do this. Thus, for instance, a recent law of the State of Connecticut, aimed at the abolition of grade-crossings and which was contested to the United States supreme court, has made it imperative upon railway corporations in that State to abolish, at their own expense, at least one grade-crossing in each year for each sixty miles of road. Under this law a railway corporation has been forced to alter the location of its tracks in the town of Bristol, to sink them below grade, to give up its old right of way, to acquire new land by condemnation, and to submit to great expenditures for damaging property and for making all these changes, which, as it claimed, it could not afford.* And for what? So that the public of the town of Bristol might be safe in the enjoyment of their rights! No doubt a laudable object, but why should not the town contribute to its attainment? It is not just for a municipality to ask or to allow a railway to bear such extraordinary expenses without assistance from the public treasury when it has been acting within the law and the need of change has come about through no fault of its own, and particularly when all of these improvements are largely for the benefit of the town. The desirability of changes in railroad operations which make life more secure in cities cannot be questioned; but it is contrary to the spirit of fairness which should exist between the municipality and the railway which has created it to destroy a large portion of the existing property of the railway, and to impose upon it much additional expense without municipal participation. And legislation of this character is a menace to the security of private property.

Many of the exactions, however, which municipalities, by virtue of the police power, put upon steam railways passing through their limits are necessary and useful, and no serious objections can be made to them,—as, for instance, regulations concerning the speed of trains under proper safeguards and the stationing of flagmen and placing of gates at dangerous points. These matters should be controlled by municipal ordinance, and little should be left to the good intentions of the railway. So, demonstrated improvements and safeguards which will protect the public in their use of city highways should be insisted upon; but in all changes the property rights of the railways should be protected, and the municipality should give heed to the facts that its prosperity and the prosperity of its railways are vitally connected, and that the duty of protecting the interests of the people at large rests upon the State.

If we turn now to an examination of the important questions affecting the relationship of street railways to municipalities, we shall see that the same common interest, the same inter-dependence of one upon the other, exists here also, but that there is a new element brought into the problem by the fact that municipalities surrender to these corporations certain local privileges in streets, which often are of great value.

It is to the State, however, that these corporations must look for corporate life. And as the power to create corporations is one of the most valuable assets of the State, in New York, Pennsylvania, Ohio, Missouri, and other States, a substantial fee must be paid for the privilege of corporate organization. Railway corporations are no exception to this species of taxation, and, although no other serious obstacles are placed in the way of incorporation, and general acts exist in nearly every State, the charter is not given until the fee referred to is paid. The State not only reserves the right to create railway corporations, but it also ordinarily retains the privilege of altering or repealing their charters, and it possesses continuing power to regulate and tax them. Formerly the State also possessed the right of granting privileges to operate railways in particular streets of municipalities, but now it is quite generally the rule to require municipal consent to any such grants, and in many instances the matter is put, by charter rights, wholly in the power of the municipality affected.

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* See the decision of the United States supreme court, February 5, 1894, in the case of New York and New England R. Co. v. Town of Bristol, reported in Vol. 49 of the Albany Law Journal, p. 171 (Mch. 10, 1894), and see 62 Conn. Reports 527.

When, therefore, a corporation has been formed to operate a street railway, and its right to exist has been secured from the State at considerable expense, it must come to the city for its franchise. And there it frequently finds that franchises are no longer given away to the first applicant who can secure the necessary influence ; that with the introduction of cable, trolley, and elevated railways the whole business of carrying passengers in and to city streets has been revolutionized, and is now assuming large proportions ; and that these facts have not been lost upon the public. Consequently, if such a corporation comes to New York city, it finds that it must purchase its franchise at auction, and must pay three per cent. of its gross earnings to the city annually for five years and five per cent. annually thereafter.* In Chicago and Philadelphia it finds that it must pay fifty dollars annually for each surface car, and in St. Louis twenty-five dollars annually for each car, while in Baltimore it must pay nine per cent. of its gross earnings and a license fee of five dollars a car. In many other cities it will find similar charges imposed.†

When it is considered that the public streets are most valuable possessions of a city in its municipal capacity ; that the necessary expenses of maintaining the city government, including its judicial, fire, police, and other departments, are necessarily great ; and that the opportunities of developing the public parks and the public charities are exceedingly varied,—it seems needlessly foolish to give away these local franchises, even with the idea of thereby securing cheaper transportation for the public. For the control of rates of fare cannot safely be put in the hands of city authorities. It must be vested in some independent State board. And it is a most delicate matter to tamper with rates frequently, and so kill the interest of private capital in the development of street-railway transportation. Moreover, the interest of the public in the streets of a city should be recognized, and, when valuable privileges are transferred to a corporation, the city, as a city, should receive compensation. Experience teaches that it can do so without materially lessening the value of the grant. To exact, therefore, an annual tax or license fee from these corporations does not seem unfair to the corporation, so long as the amount of the tax is not excessive: or unfair to the general public, so long as rates are low and the money received is appropriated to municipal purposes.

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* Laws of New York, 1890, Chapter 565, Secs. 93, 95.

† See the "Law of Incorporated Companies operating under Municipal Franchises," by A. R. Foote and E. E. Everett. Robert Clarke & Co., Cincinnati, publishers (1892), under subdivision "Charges for Franchises" in the different States. And see *Railway and Corporation Law Journal*, Vol. 1, p. 121.

Where such a franchise tax is imposed by a municipality, however, it should not be allowed to tax in any other manner the capital of the same corporation, as this is double taxation. An instance of taxation of this character is found in the city of New York, where railway and other corporations are taxed under a primitive law of 1857, which has no place in the present system of State control and State taxation of these corporations. The plan of requiring payments for franchises has steadily gained favor in this country, and it is not likely that there will be any backward step; nor is it desirable for the public good that there should be, as with the growth of our cities these franchises become more valuable, and the dangers of bribery and favoritism in granting them constantly increase.

In considering the amount to be exacted for franchises, however, municipalities should not lose sight of the fact that it is highly injurious to the public to deprive the railways of the pecuniary rewards which flow from a liberal policy toward the public. More than this, it is only in the larger cities that franchises have a salable value. In villages, towns, and small cities railways are often the chief means of promoting the public welfare; hence the disposition of public-spirited citizens and property-owners to offer free rights of way, stock subscriptions, and other considerations to induce railway building. Municipalities should also take into account the fact that they cannot always confer complete privileges in the streets, because of the interests of citizens in streets which adjoin their property. Where a municipality owns its streets, the privileges it may grant are greater than when the title of property-owners extends to the middle of the street. But in either case it is now the general rule that a steam railway cannot be established in a street without the consent of adjoining property-owners; although a horse, cable, or electric railway, in the absence of statutes, ordinarily can be authorized without the consent of citizens, as these are deemed to be legitimate and incidental uses of the street as a street. Statutes, however, may prohibit the establishment of ordinary street roads without the consent of the owners of abutting property, or they may, as is the case in New York, refer the matter to commissioners when it is impossible to get the consent of the property-owner. But, with respect to roads which are not incidents of streets, the railway must either obtain the consent of abutting owners or make compensation for the injuries which it imposes upon the adjoining property. And this rule is of the utmost importance in dealing with the relationship of elevated or underground railways to municipalities, because it furnishes a new reason in the added cost of the road why municipalities should not impose extravagant taxation upon them for their franchises.

In view of these considerations, and when it is remembered that the annual taxation of railways in some localities is very heavy, and that in different places it is governed by diverse rules, it will be seen that the value of a franchise to operate a street railway depends upon many local conditions; that the terms exacted in one place can be but a very rough guide for those to be exacted elsewhere; and that, in all places where a franchise has special value, the effort should be to impose a reasonable and fair charge in view of the local conditions.

In granting these rights to use particular streets, either with or without a money consideration, municipalities should exercise care to protect the interests of their citizens. Ordinances conferring franchises usually contain many important provisions, sometimes regarding the duration of the franchise, and generally in reference to the operation of the road and the duty of keeping the streets in a safe condition. In matters which concern the safety and welfare of the public, the municipality stands as the guardian of the people, and it should maintain a rigid control. But where the effort is to participate in the earnings of the road,—by limiting the duration of franchises or by insisting upon a share of the gross receipts,—cities should act with extreme caution. If this caution is not exercised, the danger is that we shall be irresistibly forced toward municipal ownership, — a result greatly to be deplored. To the present time, however, this question of municipal ownership of street railways has assumed comparatively little importance in this country, although it probably will be more and more forced upon public attention if attacks upon railway property do not subside. For, as private capital shrinks from undertaking the risks of great enterprises,—such, for example, as the establishment of a rapid-transit system for the city of New York,—the work is forced upon the public. No city can stand in the way of its own development, and it has always been accepted that, when necessary, cities should own their own water-works, supply gas, construct sewers, and, in short, undertake any public work necessary for the development of the individual community. But, although the ownership of railways by municipalities frequently exists in Europe,* in this country there is little disposition to make this a governmental function. There is, in fact, a strong undercurrent of conviction that our government was never intended to carry on business for the people. Indeed, in some parts of the country municipal ownership of street railways would not be lawful. Whether it is so or not will depend in each State upon the local constitution and statutes. In New York the constitution fixes the debt limit of municipalities, but does not otherwise prevent the use of a city's funds for its own welfare under legislative authority. The cities of New York and Brooklyn have united, under legislative power, to construct and operate a railway across the Brooklyn Bridge, and by a recent popular vote the city of New York has been authorized to undertake an elaborate system of rapid-transit for the city. But it is necessity alone which justifies this step, private corporations having failed to undertake the enterprise. In general the aim of the people should be to keep for themselves all forms of industrial pursuits. Surrendering them to be managed by the party in power, or by bi-partisan commissions, will benefit no one, and will inaugurate a policy that will not be long tolerated by the people. It is, therefore, desirable to endeavor to check every tendency toward municipal ownership; and, as means to this end, and to establish at the same time a closer relationship between railways and municipalities, the following suggestions are made:

First: Municipalities should impose reasonable charges only for the use of city streets, and should tax the property, but not the capital of street-railway corporations.

Second: The influence of municipalities should be exercised to prevent extreme State interference with street railways, so that investors in this species of property may receive a fair profit upon their undertakings, and the public may become sharers in this prosperity by having a constantly improving service.

Third: There should be an intelligent State control both of the organization of new railways of all kinds and of the operation of those already in existence, through boards of railroad commissioners, who shall receive full reports from railways and shall have ample authority to investigate facts, who shall respect alike the rights of the railway and the municipality, who shall decide disputed questions with moderation and justice, and who shall always remember that both railways and municipalities, to justify their existence, must serve the public interests.

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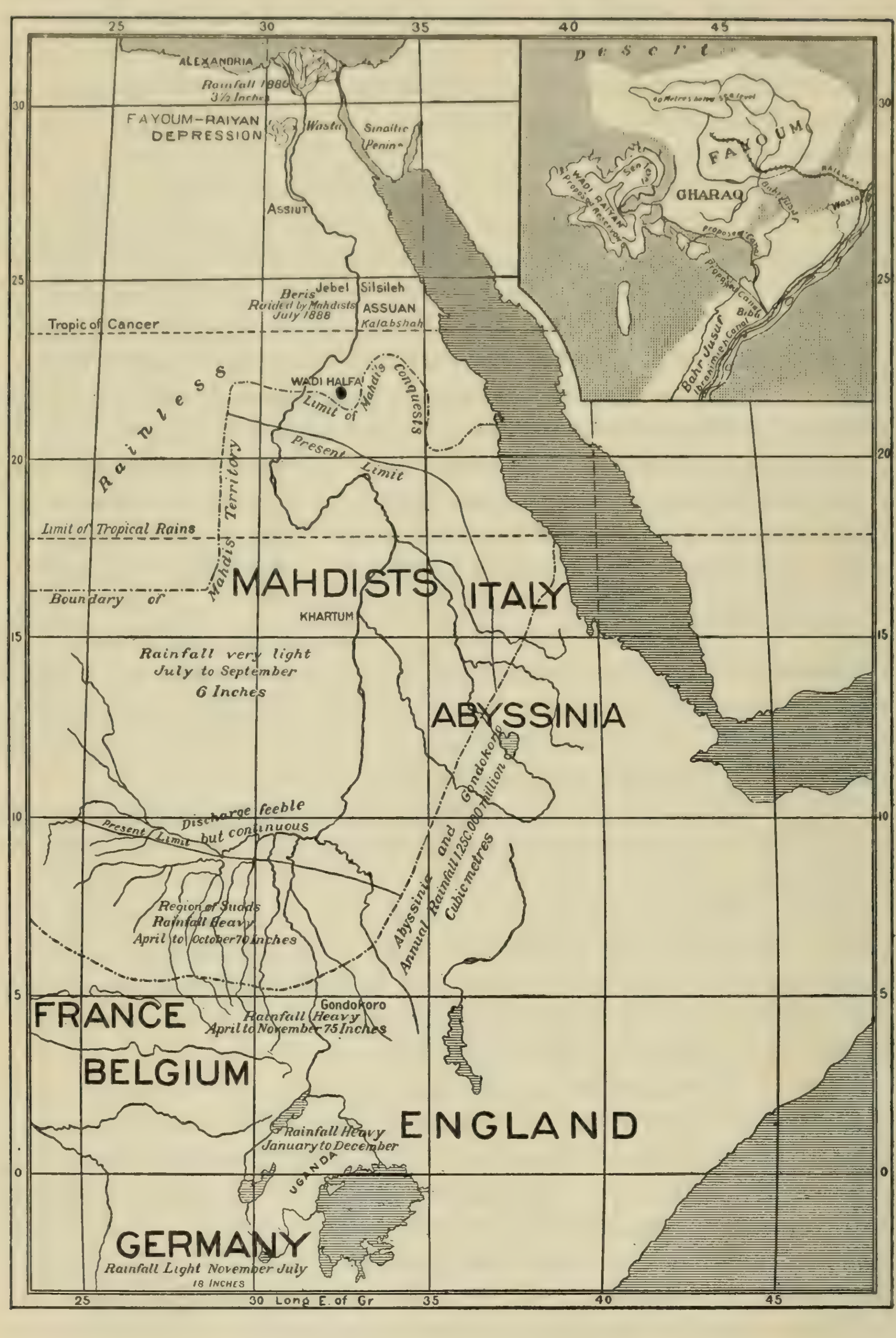
*See article on "Public Ownership of Urban Transit," by Sylvester Baxter, *Cosmopolitan*, Nov., 1894, p. 54.

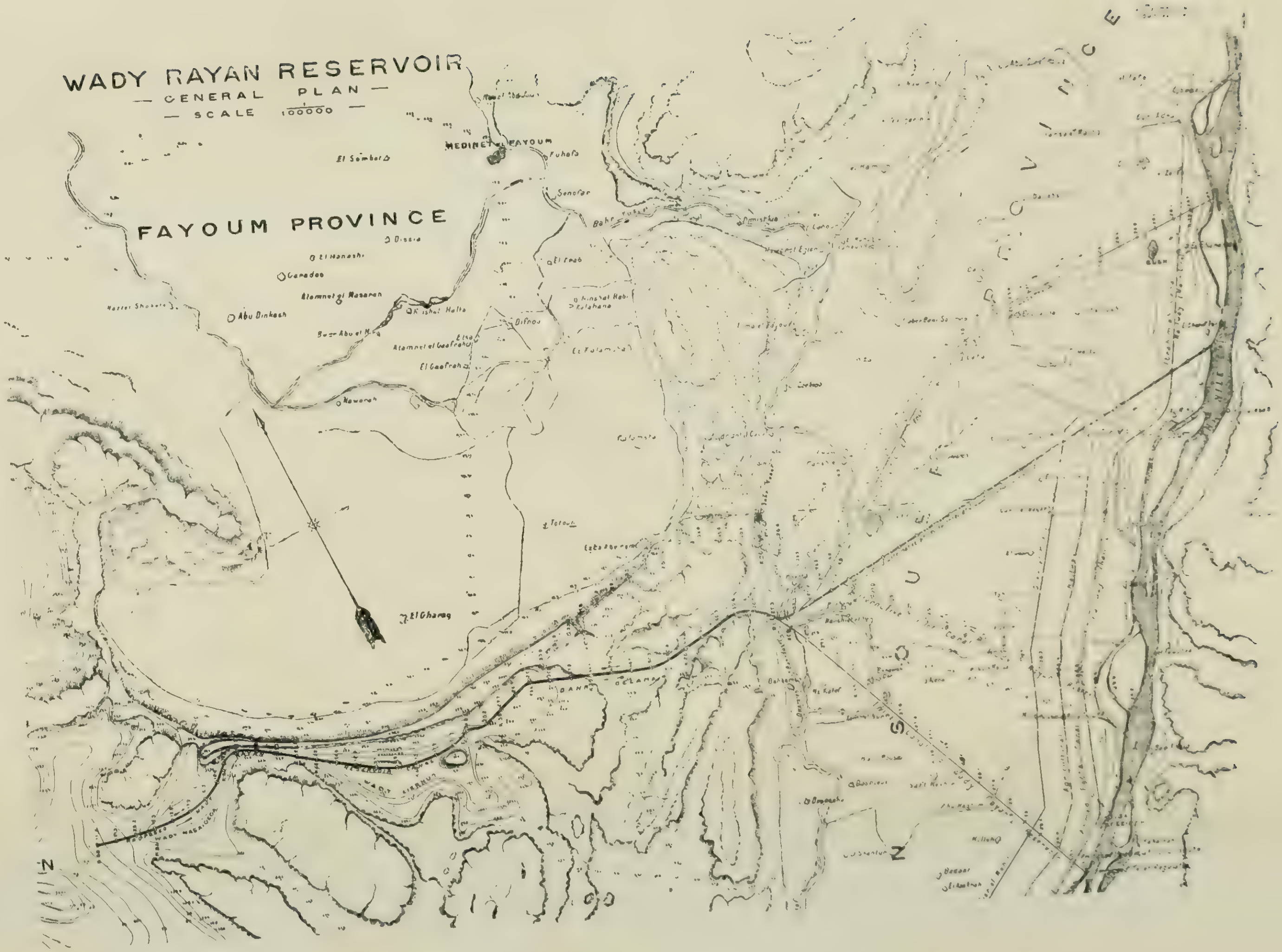


HYDROGRAPHIC MAP OF THE NILE.

ANCIENT AND MODERN IRRIGATION IN EGYPT.

By Cope Whitehouse.

THE irrigation of Egypt has recently assumed a special importance. The attention directed to the great value of land where solar heat never fails and water can be applied as required has induced inquiry into ancient systems. The engineers of the Tigris-Euphrates achieved practical results of magnificent and long-lasting character. Their works, however, have utterly perished. There was a dam of great size in Southern Arabia, of which substantial remains still exist. It failed two thousand years ago, after centuries had attested the wisdom of its builders. The Nile, on the other hand, has never ceased to be controlled by engineers, often of alien race, from the Hebrew Premier to whom tradition assigns not only the founding of the temporal fortunes of the Jews, but the construction of a canal, still bearing his name, with a record of uninterrupted usefulness lasting nearly four thousand years. From the time of Saladin, the chivalrous opponent of Cœur-de-Lion, to Mehemet Ali, little was done to change the irrigation system described by Greek travellers. The downfall of the Roman Empire suspended engineering operations on a large scale throughout the Mediterranean basin. Cathedrals rose, but aqueducts fell. The water-supply of medieval Rome still passed through ancient channels. The Pont du Gard, however, spanned with triple row of arches the ravine near Avignon, but it was not until this century that its conduit was again utilized after more than a thousand years of abandonment. A few years ago an inscription was discovered in the aqueduct below Jerusalem, which showed that the engineers of the seventh century B. C. had been able to calculate the point at which two headings driven in opposite directions would meet. While, therefore, the use of steam, and the immense advance in recent years in the construction of pumping machinery, make it certain that the twentieth century will not repeat the irrigation systems of the distant ages in which the Delta was first redeemed from marsh and desert, it is of practical importance to inquire into the ancient irrigation of Egypt, the remains which still exist, the modern improvements, and the lessons which these works teach to engineers in all parts of the world. Every engineer concerned in the training of a river, or the irrigation of a tract with insufficient rain-fall, knows that he cannot expect to find an exactly similar case elsewhere. This is


WADY RAYAN RESERVOIR
— GENERAL PLAN —
— SCALE 1/100000 —
FAYOUM PROVINCE
MEDINET EL FAYOUM
El Sombat
Fuhefa
Senofar
Bahr Yusef
Dissia
El Haneshi
Caradoo
Alamnet el Nasaren
Abu Dinkash
Kishat Halta
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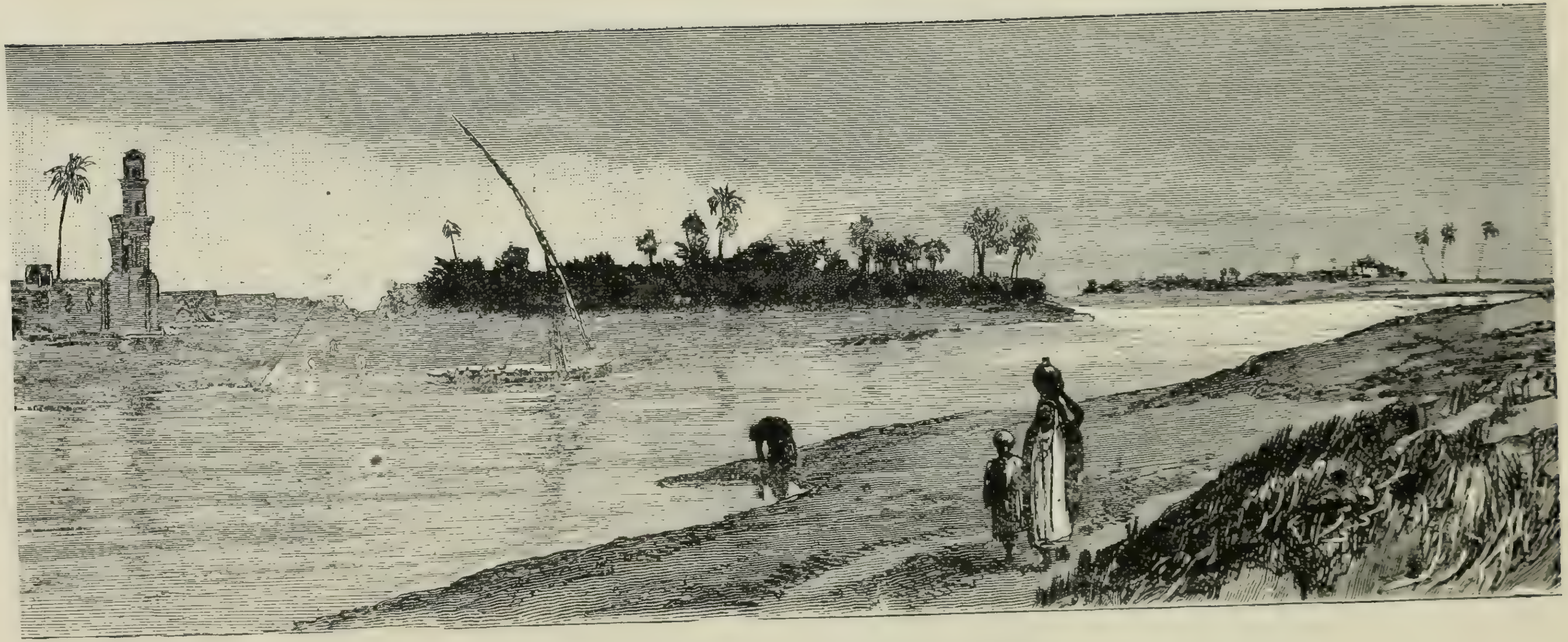
CANAL OF JOSEPH IN THE FAYOUM.

one reason, doubtless, why the literature of irrigation is so scanty. In Egypt, although the monuments are covered with myriads of descriptive pictures, and thousands of conveyances have been found relating to the transfer of land, by deed, lease, or will, no work on irrigation has reached us. Three Greek travellers express unbounded admiration for the results, but give no details as to the method. In the words of Strabo, the attention and care bestowed upon the Nile was so great as to cause industry to triumph over nature. "The Egyptian soil, when inundated by the natural rise of the river, is very fertile, but it is by irrigation that it produces the most abundant yield. Industry has completely succeeded in rectifying the deficiency and irregularity of the natural supply; so that, in seasons when the rise of the river has been less than usual, as large a portion of the country is covered with water, by means of canals and embankments, as in seasons when the rise of the river has been greater."

The latest irrigation reports of the Anglo-Indian engineers show that even in Upper Egypt this is not now attained. The valley of the Nile from Assouan to Cairo resembles those rivers of the United States in which a level bottom-land borders a river-bed, and steep hills rise on either side. As the inundation is never more than a few feet higher than the long, narrow plain, the canals and embankments



THE BAHR JUSUF, OR CANAL OF JOSEPH.

At Behnesa, fifty miles south of El Lahun, the entrance into the Fayoum.
Length, 190 miles; Flood Discharge, 2,863 cubic feet per second; Minimum Discharge, in June, 409 feet per second.

This water-course, partly natural and partly artificial, has been utilized continuously since B. C. 1600 to supply the Fayoum. The excess and drainage is evaporated at the rate of 98 inches per year in the Birket el Qerun; with a surface of 78 square miles, 133 feet below sea-level.

mentioned were required in order to secure for every acre a supply of water, and—what is of equal importance—in order that the silt-charged inundation should remain as a tranquil pool for not less than ten days It then becomes equally desirable that the waters should be run off at the earliest possible moment. No extension of area beyond the foot-hills is possible. No desert is ever irrigated, except those alluvial deposits covered with a few inches of wind-blown sand to which the term desert is sometimes loosely applied. The embankments seen by Strabo and built, perhaps, by Sesostris are still in use. The levee and the railway form a continuous line on the west bank. Cross embankments separate the plain into vast compartments, technically termed basins. The canals are needed to gain head. A basin is not usually filled directly from the river, but takes its water from a point somewhat higher up than the southern bank.

The plain itself tilts to the west. Thus the corner nearest to the river and the entrance of the canal is that which is most likely to be insufficiently covered. Again, as the earlier inundation is more richly charged with silt, it is an object of anxious thought to secure the equal distribution of the alluvial deposit. Within a few years about four million dollars have been expended, under the direction of Col. Ross, in extending and arranging the network of canals, and in substituting

MEDINET EL FAYOUM.

MOSQUE BRIDGE OF KAIT BEY.

stone culverts for the discharge. The primitive method of cutting a bank has been almost wholly abandoned. About sixty miles south of Cairo a magnificent work has been erected, designed by Col. Western, with a double row of gates for the discharge of the great Koshesha Basin, into which the discharges from Upper Egypt are to a large extent passed. Thus, in September, the Nile valley to the south of Cairo consists of a series of lakes, descending like steps, by the side of a river, whose rapid current is often higher than the still ponds. It is the task of the so-called Nile corvee to prevent a breach in the cross-banks, assailed sometimes for days by waves of considerable dimensions, as well as to confine the river itself to its prescribed course. It has never been true, as Shakspeare puts it: "The higher Nilus swells, the more it promises." On the contrary, a high Nile delays sowing; for the dramatist rightly says: "As it ebbs, the seedsman upon the slime and ooze scatters his grain, and shortly comes to harvest."

In Upper Egypt, therefore, the system of cultivation is that of inundation, except on two perennially irrigated areas, supplied with water conducted from the Nile, either through a canal of the remotest antiquity, bearing the name of Joseph, and traditionally ascribed to the son of Jacob, the prime minister of Pharaoh, who reduced the independent inhabitants of the Delta to the position of tenants of the

FORDING A CANAL.

crown, in pursuance of the system of a regulated water-supply, or through the Ibrahimieh Canal, named after the celebrated son of Mehemet Ali, but due to the energy of the Khedive Ismail. The ground retains sufficient moisture for a single crop. The whole operation of filling and emptying the basins is one of great delicacy of manipulation, and requires a centralized authority with arbitrary powers. Hence, intimated Herodotus, Egypt must always have a king. These basins are the areas of verdure described by the tourist. He ignores

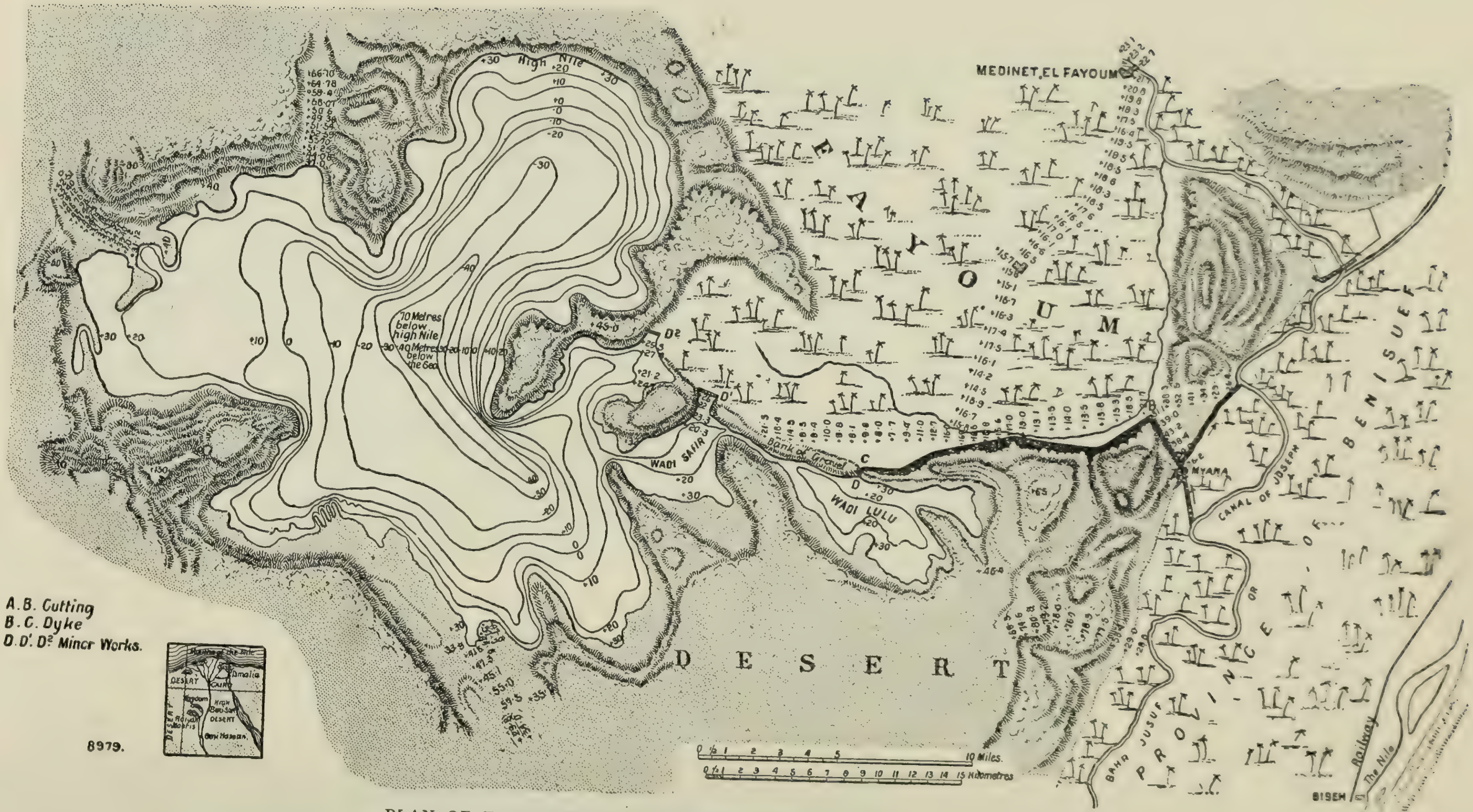
MILL IN EL BATS.

the three months during which these fields are a sea, the villages surrounded by a marsh, and the cattle dependent upon fodder. "Although Egyptian wheat costs almost nothing to raise, it is so hampered by costly transportation and excessive taxes that it is undersold in the English market by American and Indian wheats, and the owners of basin lands hardly keep soul and body together unless the basin inundation is conducted (by the government) in the best possible manner" (Col. Ross, late inspector-general of irrigation). To increase his resources the peasant adopts the picturesque method of cultivating a small area by lifting the water after the inundation crop has been reaped. "The summer irrigation of the basin is remarkable for the excessive amount of labor bestowed upon it. For eight hours' hard physical labor from March 15 to August 15, or five months, the man practically works for 50 to 60 piastres ($2.60 to $3.00). This is equivalent to wages of one-third of twopence half-penny," or less than two cents, a day.

By the side of the valley of the Nile lies the unique depression of the Fayoum. Its present cultivated area is about 300,000 acres, of which 70,000 are planted with summer crops, chiefly cotton. The inundation, with its attendant plagues, is excluded. It has been identified by me with the land of Goshen, and its fertility and strategic importance confirm the view that it was, in B. C. 1400, the best of the land, peculiarly adapted by its perennial pastures for the Hebrew allies of the Shepherd-Kings. It is the garden of Egypt, from whose vineyards, palm-groves, and fig-trees come the fruit sold in Cairo; and the Lake el-Qerun furnishes the capital with an unlimited supply of wholesome fish from its brackish waters. If cotton is grown, it is followed by a winter crop of wheat, clover, or beans, and this is succeeded by a crop of millet. Five crops are taken off the same ground in thirty-one months. Three are sometimes harvested in fifteen months. The land-tax is $720,000 ; but there are heavy railway charges and other contributions to the treasury, including the corvee, or forced, unfed, and unpaid labor, and the infamous *rachat militaire*, invented and imposed as a kind of capitation tax by the British authorities. But another source of revenue remains wholly neglected.

The potentiality of wealth resulting from the conversion of a single million cubic meters per day (four hundred feet per second) falling one hundred feet, converted into electrical energy by dynamos working in a climate where frost is unknown, is obvious. It was outlined in my earliest researches, in 1882, and Gen. Stone was quick to perceive its value. The reproduction of a photograph of the great ravine of el-Bats shows that, as the plateau is below the level of the Bahr Jusuf, the water which rushes down its bed might be utilized as at Niagara. The mill driven by an undershaft wheel is one of many employed for grinding durra, a species of millet. Similarly, water-wheels, with wooden boxes or jars, alternating with paddles, used in irrigation, prove the commercial value of the wonderful gift of nature, which is not now utilized except in an infinitesimal degree. American engineers should note this, so that, if, or when, the time comes in which they are restored to the footing on which our industries stood prior to the British occupation, an opening may be found for electrical machinery, and trolley lines traverse the Fayoum and carry its produce to Cairo. The city itself will, in my

PEASANT LIFE IN FAYOUM—GOSHEN.



PLAN OF THE RAIYAN—LULU RESERVOIR; WITH LINE OF CANAL.

Approved by Col. Western, R. E., Director-General of Works, Draughted by Mr. Cope Whitehouse, August, 1888.

opinion, be lighted by water-power. The native governor of the Fayoum, Mahmoud Bey Sabri, was last year in treaty with a European company to light the bazaars of Medinet el-Fayoum, the capital of his province, from a dynamo to be established about two miles away.

The competition of Egyptian cotton, not only in European markets, but in our own, has become a matter of most serious commercial and financial importance. It is evident that a crop sown in spring and taken off in the autumn can never be grown on inundated land. The cultivation of the Delta is, also, by irrigation, as opposed to inundation. The flood-waters of the Nile are excluded from its fields. Out of a thousand million cubic meters per day discharged from equatorial Africa in a maximum flood, through the narrow pass between the Pyramids and the Citadel, not one-tenth is utilized. The rest is conveyed to the Mediterranean chiefly by two branches of the river, defended by levees. If the ancient accounts are to be treated as trustworthy, and certain medieval maps considered authentic copies of those in use seventeen hundred years ago, the river had twelve lines of discharge, each one carried to the sea. The reclamation of the rest of the Delta would mean the addition to the productive area of 1,500,000 acres, 600,000 of which require little treatment to restore them to the condition in which they contributed to the famed luxury of Cleopatra. This exclusion of the inundation was, according to the ancient records, facilitated by the discharge of a portion of the surplus flood into the vast depressed region of the Fayoum ; and, as I have maintained, also into the Raiyan Basin lying to the south. The inspector-general of irrigation, Major Brown, accepts in its entirety my view of the use of the Fayoum, as that reservoir and escape, deemed the greatest engineering work of the ancient world, and known as Lake Moeris. Whether the Raiyan Basin was used is a disputed point. The public-works ministry, however, concede that, as the map shows, it could be so utilized.

The irrigation of the Delta was begun in the early part of this century ; and, in 1842, two open dams were commenced, to close the branches of the river when the Nile has fallen, and force the water into a network of canals, whose beds are higher than the bed of the river. If Napoleon proposed some sort of dam, he only contemplated an increased head for inundation. The Barrages were constructed, at a total cost of twenty million dollars. In 1863 the Rosetta Barrage was closed for the first time, but reopened almost immediately afterwards, owing to a settlement of part of the work. Commissions of inquiry repeatedly sat,—in 1863, 1865, and 1867. The most eminent European engineers were consulted by the Khedive Ismail. Their conclusions were adverse, based not merely on the extreme frailty of the structure, but on other economical grounds. In 1884, however, it was determined to strengthen the foundations, put in new gates, and complete the canal-system to be fed from the pool thus formed. The work was executed by Col. Western with great skill. The result has been a very large increase in the cultivation of cotton, but without any considerable addition to the cultivated area. Cotton is grown instead of cereals. Sanitary and other factors have shown themselves to have been deserving of greater consideration than they received from the Anglo-Indian engineers, and the opposition of Linant and the adverse decision of Sir John Fowler are still considered by many to have been fully justified.

No further extension of cultivation in the Delta is possible without a storage reservoir; nor can the farmers of Upper Egypt be allowed to use pumping machinery, and convert the inundated basins into irrigated fields, until the deficiency thus created has been supplied from the surplus of the flood. This is the problem which, having remained dormant since the Mohammedan conquest, and barely mentioned by engineers before 1882, is now exercising the minds of the civilized world.

"The necessity of some vast scheme of storage for the increase of the summer supply of the Nile is universally admitted, and has been before the public in definite shape since Mr. Cope Whitehouse put forth the Wadi Raiyan project in 1885." (*Engineering*, Feb. 16, 1894.)*

The public-works ministry, on Nov. 8, 1894, obtained the sanction of the council of ministers for a projected storage reservoir in Nubia. The budget for 1895 allots the sum of £154,000 ($770,000) for the work to be executed this year. Sir B. Baker has been appointed consulting engineer to the department of reservoirs, which is continued under the direction of Mr. W. Willcocks, an Anglo-Indian engineer, on the permanent staff of the Egyptian government. The scheme proposed is an open dam with its crest at R L. 106 meters, or 339 feet above mean sea-level. The contents of such a reservoir would be 1,064,000,000 cubic meters, or 37,590,000,000 cubic feet, or about 250,000,000,000 gallons. The water would be held up to a head of 15 meters (48 feet) and ponded back for 209 kilometers (about 130 miles). The amount of water available is less than one-third of the

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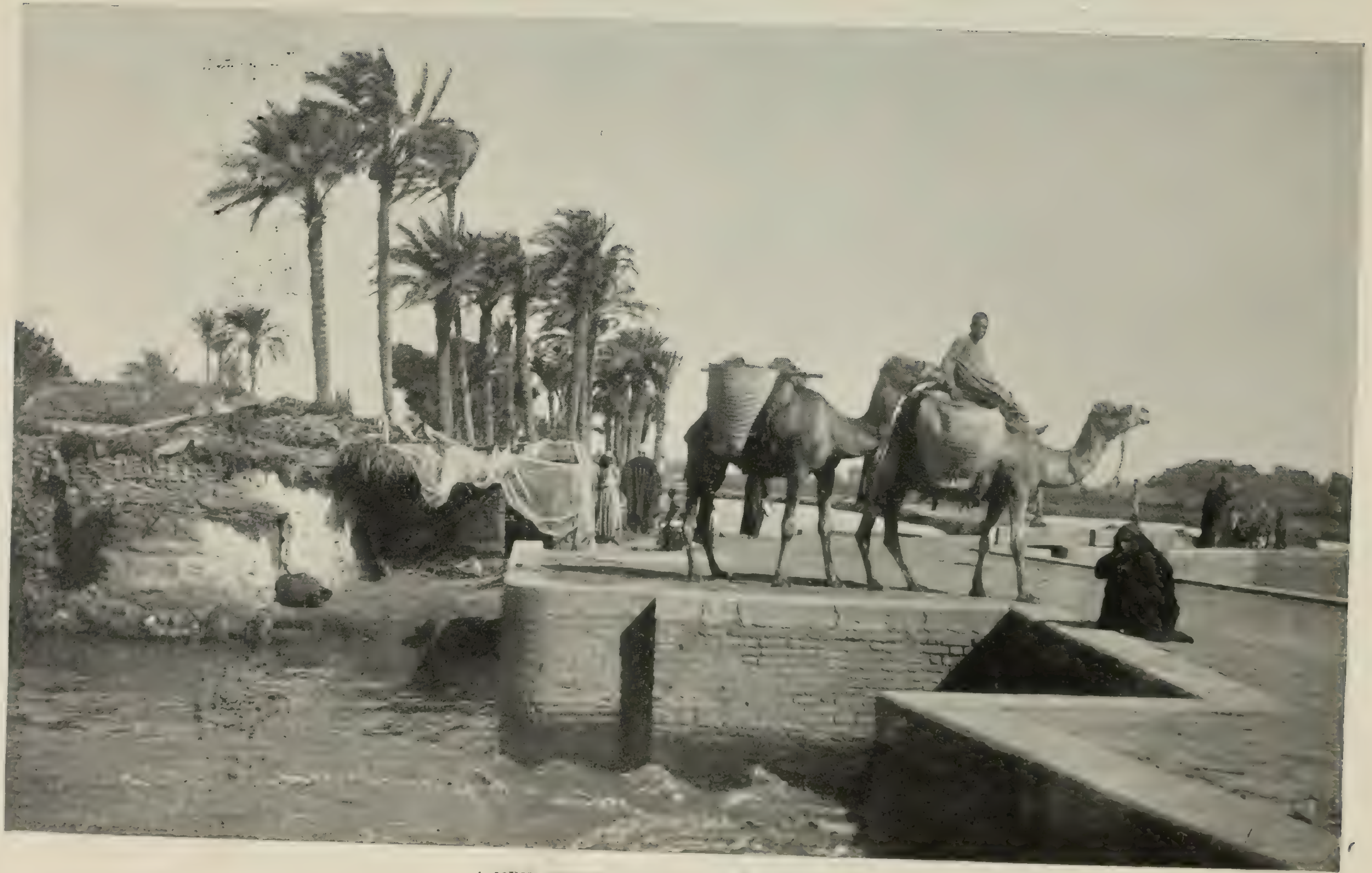
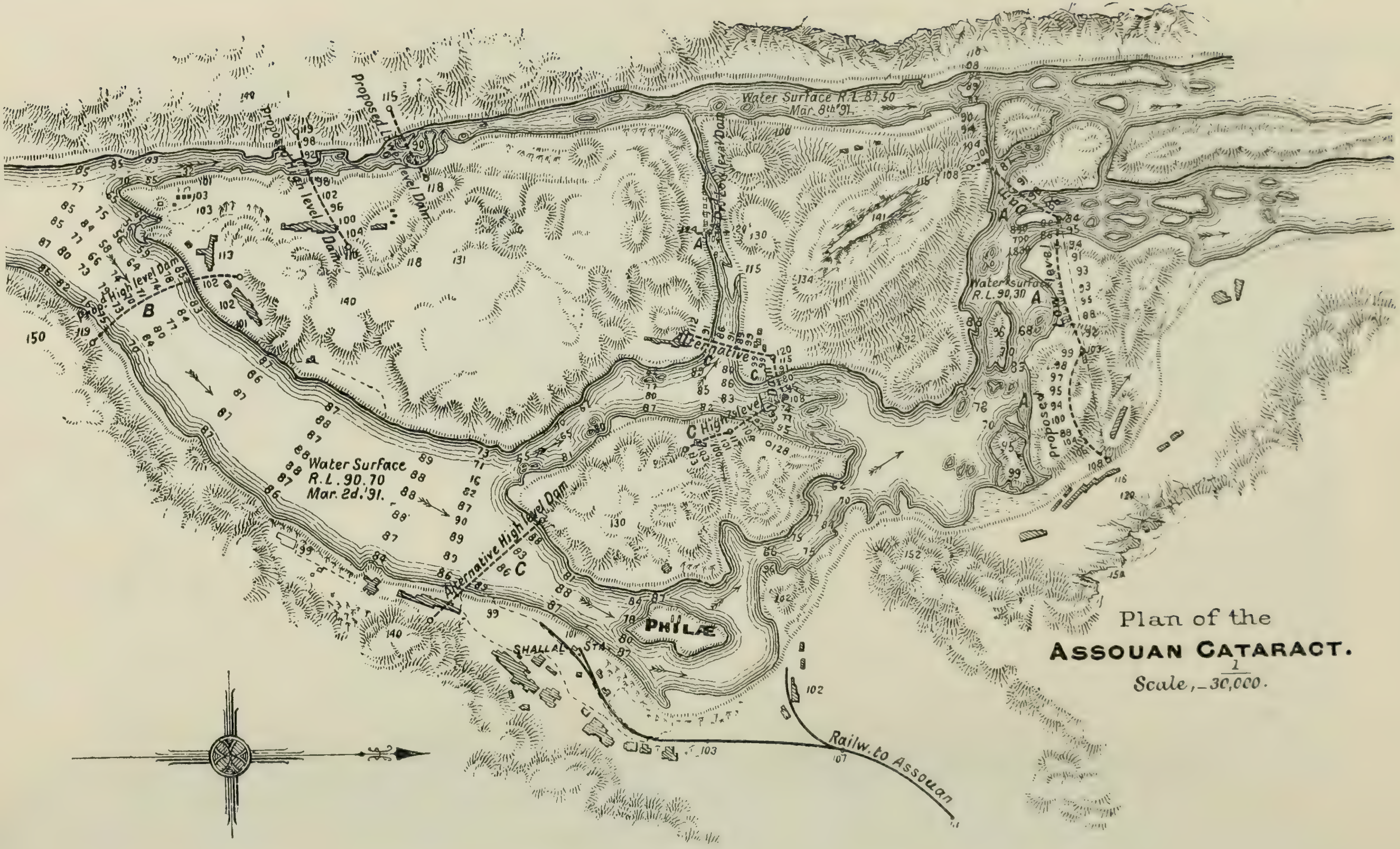
* "Such authorities on Egyptian Irrigation as Sir C. Scott Moncrieff, Col. Western, Col. Ross, and Major Brown have recorded their opinion. So extensive indeed has been the literature that the name of the Wadi Raiyan ought to be as well known to the world as that of the Lake of Geneva." W. E. Garstin; Note, Public Works Ministry, Cairo, 1894.

See *Engineering*, 1885, Sep. 11; 1887, Sep. 29; 1888, Sep. 14, 21; 1890, Sep. 19; 1891, Oct. 16; 1893, Jan. 6, Feb. 3, June 16, Dec. 8; 1894, Feb. 16, Ap. 20, June 15, Aug. 3, 10. Egyptian Irrigation; W. Willcocks, pp. 301-336, 1889. The Fayoum and Lake Moeris, Major Brown, 1892. Notes, pamphlets, and maps in British Museum, London, and Astor Library, New York.



A NEW REGULATOR IN THE FAYOUM.



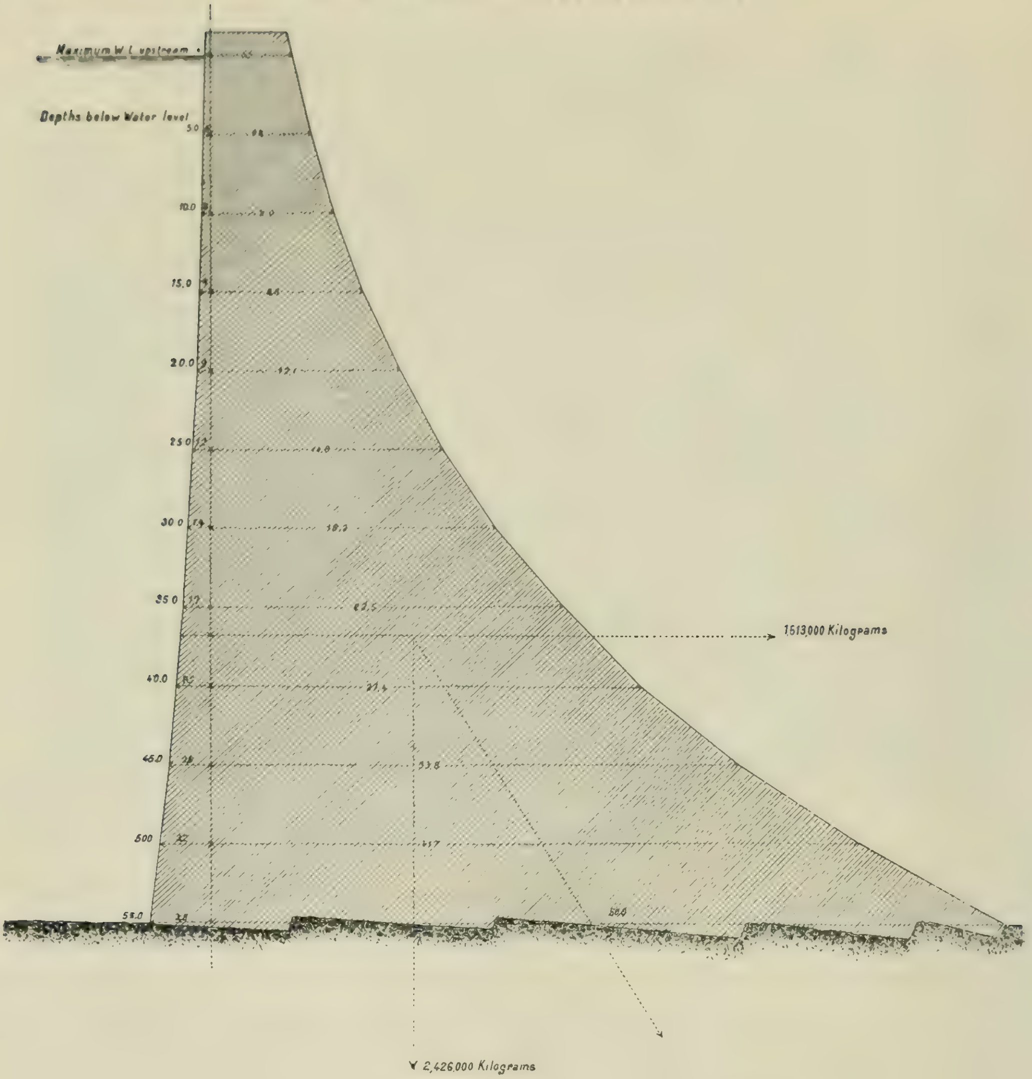
Plan of the

ASSOUAN CATARACT.

Scale, — $\frac{1}{30,000}$.

THE GREAT RAVINE OF EL BATS.

minimum required for the conversion of the valley of the Nile from flood cultivation to perennially irrigated fields, and the reclamation of the remainder of the Fayoum and the Delta. In order to extend Egypt to the limit of production attained by its former rulers, the Shepherd-Kings, the Ramesside Pharaohs, or the Ptolemies, the estimate made by the public-works ministry would require further substantial increase. Mr. Garstin, under secretary of State, gives the following figures: Upper Egypt, 1,160,000,000 cubic meters; Middle Egypt, 950,000,000 c. m.; Lower Egypt, 1,551,000,000 c. m.; or a total of 3,661,000,000 cubic meters (854,000,000,000 gallons). The expense of this dam as compared with that originally proposed, with a head of 22 meters and a capacity of 3,700,000,000 cubic meters, will not be reduced in any corresponding proportion. Even if this were the case, the immense value of an adequate supply of summer water, with its estimated annual value in increased production of $60,000,000, is sufficient to show that, should the cost of this dam not exceed $7,500,000, while a higher dam could, it was said, have been constructed for $12,500,000, the expense does not enter into the question as a determining factor. As the expropriation of the cultivated land to be drowned is only reduced by a little over one-third; as the iron-work remains the same; and as the difference is confined to the relatively



SECTION OF PROPOSED SOLID DAM. (RANKINE.)

small saving in reducing the thickness and height,—it will be seen that the adoption of this plan is a defeat suffered by the department of reservoirs. The archæologists were roused by a proposal to destroy the temple-crowned island of Philæ, and other ancient remains of historic value below the level of the proposed reservoir. They have thus far gained the day.

The structure proposed is shown in the accompanying illustrations. It may be observed that the dam rests on the surface of the rock, which is neither cut into steps, sloping the right way, nor secured by projecting masses of the rock itself. The curves are useless; and the masonry in the buttresses might more advantageously have been distributed through the dam itself.

If the Assuan dam is the best which Mr. Willcocks could design, the Raiyan plans were drafted with the avowed object of securing the

15 METRES OF WATER ON SILL OF UNDER SLUICE

In calculations for stresses with the Reservoir full, the parts of the dam to the Left of XX' above ***EF*** *are neglected*

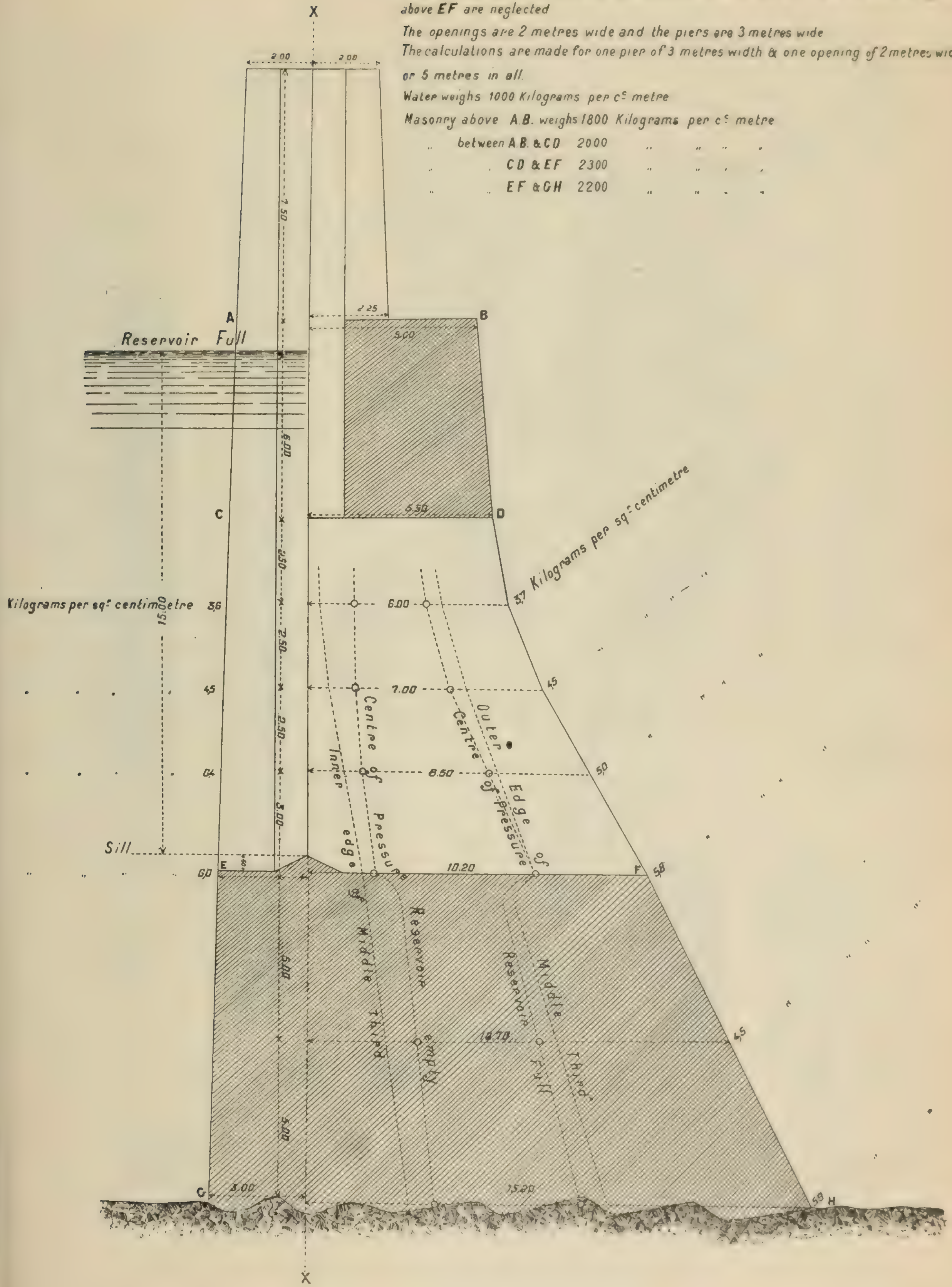
The openings are 2 metres wide and the piers are 3 metres wide

The calculations are made for one pier of 3 metres width & one opening of 2 metres width, or 5 metres in all.

Water weighs 1000 Kilograms per c^{c} metre

Masonry above A.B. weighs 1800 Kilograms per c^{c} metre

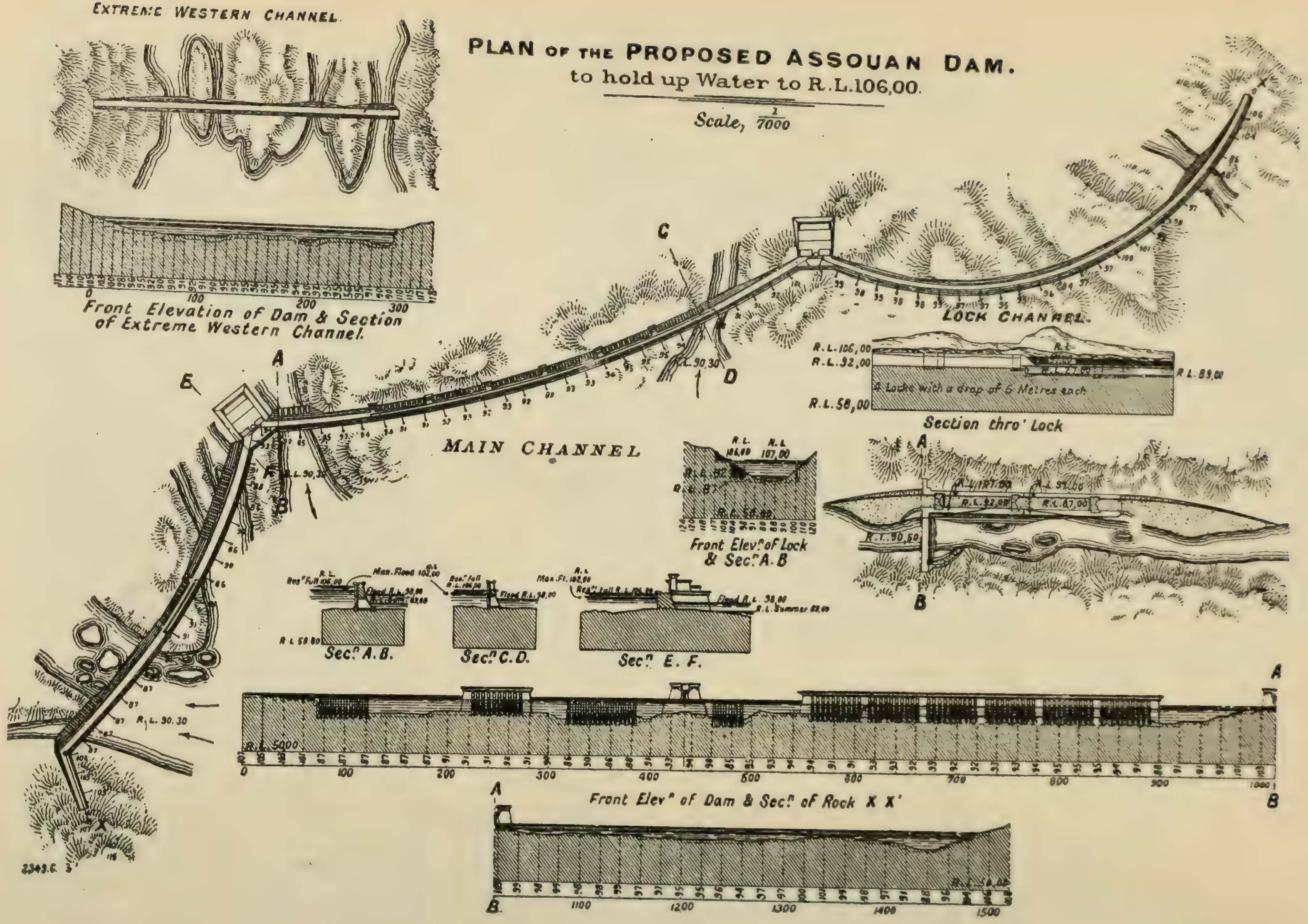
"	between A.B. & CD	2000	" " " "
"	" CD & EF	2300	" " " "
"	" EF & GH	2200	" " " "



PLAN OF THE PROPOSED ASSOUAN DAM.

to hold up Water to R.L.106,00.

Scale, $\frac{1}{7000}$

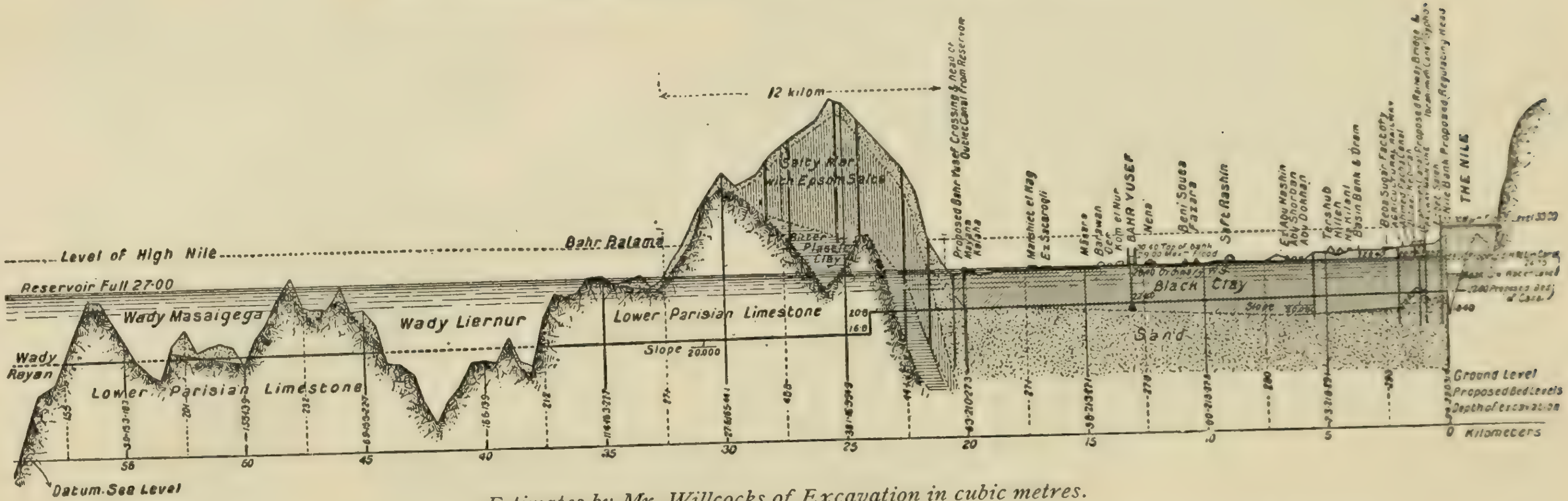


rejection of my scheme. The ancient system of regulating the Nile by Lake Moeris led to the Raiyan project. It was submitted to the three commissioners by the department of reservoirs in a form not approved by me. It will be noted that the inlet and outlet canal is not perpendicular to the Nile; that there is no apparent necessity for any canal at all traversing the flooded valley; that the canal has a slope to the west which is unduly prolonged; and that the design is, in other respects, open to objections which led me to refuse to accept the decision of the commissioners as final. It is fortunate for me that the errors and misrepresentations are of such a character as to dispense with any need for elaborate refutation. Lord Rosebery, Lord Cromer, and Sir C. Scott Moncrieff were aware of the intention to misrepresent the physical facts of the Raiyan isthmus; and they sanctioned the astounding perversions of the elementary laws of hydraulics. The American engineer will greet with derision an outlet canal which discharges water up a slope, with an outfall 27 feet above the intake. Apparently, in Egypt, a straight line is not the shortest distance between two points; and water, in a lake, does not find its own level, but retains a permanent angle, even when flowing in the direction opposed to that by which it entered. It will also be noted that the double lines, which represent alleged borings, were never carried down to bed-level. The profile of rock-cutting, is, therefore, the product of the imagination of the director-general of reservoirs. It was not thus in the days when Gen. Stone was chief of the bureau of surveys.

England considers Egypt as subordinated to the Anglo-Indian empire. Every effort to develop Gibraltar has met with strenuous resistance. The "Rock" is primarily a fortress, and can never—so English statesmen maintain—be allowed to become a metropolis at the gates of the Mediterranean. Similarly, if Egypt were obliterated from the map, and the Nile were reduced to the condition of the Tigris-Euphrates, it would unquestionably strengthen the present British empire. The policy is intelligible, and, if it shocks humanity, must nevertheless be considered entirely rational. It found expression in the words of a despatch addressed to me by Lord Salisbury on January 12, 1889, in which it was said that, "after full consideration, the Egyptian authorities have come to the conclusion that they cannot adopt your proposals, while the benefits which might accrue from their adoption are fully acknowledged." "I am to add," wrote Sir Julian Pauncefote, now ambassador at Washington, "that Her Majesty's agent and consul-general, while regretting that Egypt is not able to profit by the execution of the project which you have prepared with so much care and skill, states that he has satisfied himself that it has been considered with the greatest care and attention

LONGITUDINAL SECTIONAL OF PROPOSED INLET AND OUTLET CANALS FROM PLATE XVI. OF THE PLANS OF THE RESERVOIR DEPARTMENT, EGYPT.

Draughted by W. Willcocks, M. I. C. E., Director-General of Reservoirs.



Estimates by Mr. Willcocks of Excavation in cubic metres.

[True cost $1,000.]				[No such canal is required.]	
Sand	602,000	Marl	7,592,000	Clay	6,996,000
Rock	3,792,900	Rock	4,582,000		
Cost	$1,516,800	Cost	$3,730,800	Cost	$1,896,000

NOTE.—The dotted horizontal line has been added to the original plate.

The names Masaigega and Liernur were substituted by Mr. Willcocks, in 1894, for those given by Mr. Cope Whitehouse, which had been approved by the Egyptian government in 1888, accepted by cartographers, and officially adopted by the British war office and the Italian ministry of agriculture.

Surface of reservoir at R. L. 30, 727,000,000 square metres.
at R. L. 23, 607,000,000 " "

Contents of Raiyan Reservoir between R. L. 23 and R. L. 30, 4,711,000,000 cubic metres.
Contents of Assouan Reservoir - - - - 928,000,000 " "
Estimated cost of Assouan Reservoir (as amended) $6,500,000.

by Sir C. C. Scott Moncrieff and Colonel Ross, who, as you are aware, are the responsible advisers of the Khedivial government in such matters."

A great irrigation work in a foreign country is like a masterpiece in an alien tongue. Its plans cannot be transferred to another place without grave risk. Each irrigation problem stands by itself, governed by local conditions; and the form as well as the position of a dam must be controlled by the physical factors peculiar to the spot. Each river has its own life. The catchment-basin of its source and the influences of its early career must be studied. The engineer who is set to train a Kanawha or equalize the flow of a Rio Grande knows that he must conciliate nature, and rather seek to induce the forces at his limited disposal to combine and assume a new, but still natural, form, than to treat the tremendous energy and ceaseless activity of a river as if it were like the imprisoned force of water, heated or superheated, in its steel cell.

The Anglo-Indian engineers in Egypt have proposed their solution of the Nile problem. The details of their plans are useful subjects of study. They have been shown how the engineers of a far-off period met the same difficulties, and accomplished stupendous results in the development of the country to an ideal standard. The stability given to their works is an object-lesson of supreme importance. It is not, perhaps, to be expected that the engineer of a private company should attach too much value to such a length of life as that enjoyed by the Bahr Jusuf. The government and municipal corporations, however, are borrowing money to be repaid by posterity. Their engineers may rightly be asked: What is the probable life of your proposed dam? How long would your canal continue to supply the wants of the population dependent upon it, if in the ebb of civilization no thought or money were employed upon it for centuries? If, in the recurring cycles of engineering enterprise, it should be found necessary to obtain the maximum of work from these forces, will anyone claim, four thousand years hence, that your scheme in its entirety was the best possible, and propose, for an expenditure not amounting to one per cent. of the original outlay, to bring it to its previous state of highest efficiency?

The engineer who accomplishes this in the American Sahara will have written his name with water in sand. The phrase fails in its proverbial application. His fame will endure in the perennial stream of life-giving water and fertile fields; while the bronze of the victor in internecine conflict proves only the fleeting record of a moment.

THE PROFESSIONAL MECHANICAL INVENTOR.

By Henry Harrison Suplee, M. E.

THERE is probably no more pathetic figure in the whole range of fact or fiction than that of the old-time visionary inventor, filled with the one idea of his great discovery,—great to him, but nearly always nothing or less than nothing to others. All of us have heard of him, many of us have known him, and the story of his struggles and trials, his failures and successes, may be read by those who have never met him, if they will take a thoughtful walk through the model rooms of the patent office or turn the leaves of back numbers of the *Gazette*.

There seems to have been a strange fatality about the early history of the development of applied mechanics, not unlike that of the curiously empirical art of alchemy, from which indeed modern chemistry has been developed ; but chemistry, as a scientific study and application of the natural laws of molecular composition and decomposition, has had a definite existence since the beginning of the century now drawing to its close, while the application of the science of controlled motion to the utilization of the mechanical forces of nature is even yet denied by many to be a practical possibility. Nevertheless the science of invention, if we may have the temerity even now to call it a science, has reached a stage in its progress where it has found both employers and exploiters, and it is now no longer a dubious compliment for a man to be called an inventor, especially if it be known that the methodical, business-like person to whom the title is applied is retained at a comfortable salary by a powerful corporation or is reaping a substantial harvest of royalties from the products of his inventive ability.

"Science," as Brougham has tersely defined it, "is knowledge reduced to a system," and, if ever any mass of knowledge has been waiting to be reduced to a system, it is the vast, unclassified, almost unrecorded accumulation of experimental knowledge, successful and unsuccessful, which for so long has been paraded before the earnest student of applied mechanics under the misnomer of "practice." Reuleaux has rightly said that "theory and *practice* are not antagonistic, as is often tacitly assumed. The popular antithesis should rather be between theory and *empiricism*." It was as the product of empiricism, often indeed successful, but far more frequently the reverse, that the title of inventor acquired its one-time questionable repute ; it is as the result of the practical application of theory, combined with the scarcely yet known art of cultivated observation, and verified by systematic records of past experience, that this title has been turned from a reproach to an honor, and that invention has become a legitimate profession with its specialists in every branch.

There can be no doubt that the too well deserved repute of the inventor for general unreliability was largely due to his empirical methods. The old rule of " cut and try " was the general one, and the application of scientific analysis the rare exception. A most striking illustration is found in the transformation of public opinion with regard to inventors of so-called " flying-machines." Nearly all inventors were formerly supposed to be more or less weak in the " upper story," but, if it became known that any man, however intelligent or scientific, was at work upon a *flying machine*, his reputation for sanity was endangered almost beyond hope of salvation. To-day we have the ablest engineers, mechanics, and physicists studying the problem with all the ability which modern training can give, and lo ! public opinion promptly trims to meet the new conditions, and awaits results with rather impatient expectation. This is but a single example of the changed attitude of public opinion, and, like many changes, it has been carried rather too far by some ; for it must not be supposed for an instant that any system of originating inventions can be devised which will dispense with the genius of the inventor. Rather is it desired to place mechanical invention in the same plane as invention in other branches of human originality, so that the inventor may receive a special training, just as the musician is trained in the science of musical composition, or the poet in the rules of metrical rhythm ; not to give the ideas,—these must come from the intuition of the brain,—but to enable the conceptions to be shaped, so to speak, in the most available and correct form without innumerable trials.

The study of theoretical kinematics, or the science of controlled motion, may be compared to that of analytical chemistry, in which the given article, whether machine or compound, is picked to pieces and its composition determined and studied. This is often useful and desirable in both lines of work, but, in mechanical subjects at least, the charge has been made, and with some degree of justice, that the professor is always just too late, and does not tell you how to do it until you have discovered it without him. In chemistry, however, the synthetic branch is being actively exploited, with important present results, and tremendous possibilities in sight. Synthetic kinematics is as yet hardly more than a name, although, as a branch of the applied subject, it is taught with gratifying results at Charlottenburg, and indeed used by many elsewhere who have had to work out the principles for themselves.

Again it must be emphasized that no system can take the place of individual inventive genius, any more than a knowledge of the science of musical composition can make a man a composer; but for the professional inventor, who is retained to develop subjects laid before him, or rather to invent devices to accomplish ends required of him, the science of combining mechanical ideas has become an absolute necessity. To speak in a parable, the science of applied kinematics may be likened to the now famous Bertillon system of identification of individuals, each subject being classed in some one of a few great groups, determined by corresponding peculiarities, and these groups being then gradually sorted into lesser and lesser groups, until there are left but a few possible examples from which selection may be made. The difference between the two systems, however, is a most important one, applied kinematics proceeding in an order exactly the reverse of that employed by the Bertillon identification system. Instead of trying to identify the individual with the record, the problem in connection with invention is to find from the record a combination, or set of combinations, which will meet, to a more or less satisfactory extent, the especial requirements of the case under consideration.

This naturally presupposes the existence of a record so classified as to enable the weeding-out of combinations not readily and definitely available for the purpose in hand, and to which new fundamental chains of mechanism may be added should the advance of discovery make it necessary. It is just such a record which, while lacking tables, dictionaries, or indices, may be made by every man for his own work from his own experiences and from those of others in his especial line, by proper study and use of the methods of theoretical and applied kinematics; and, while this branch of knowledge, as has been already said, has not yet been fully reduced to a system, much has been and is being done in this direction.

But, it may be asked, what has all this to do with the subject of this paper? Simply that it is to the actual and extending use of the principles above indicated that the profession of invention owes its development from the empirical and uncertain status of the recent past to its present repute. Nothwithstanding the fact that there has as yet been little or no training of inventors in the methods of applied kinematics, and the fact that the notations and classifications which have been so ably devised by Professor Reuleaux are just beginning to be appreciated, the methods upon which the system is based have, to a greater or less extent, been actually used by nearly all those who have successfully developed the profession of invention, and are doubtless destined to be more and more extensively used in the future.

A system in itself, however, is of but little value without the capacity to use it, and without ideas to which it may be applied. These, every one will at once say, cannot be made to order, or furnished upon call; and it is true of invention, as Archimedes long ago said of mathematics, that there is no royal road by which it can be reached. But it may not be amiss to note that there are no royal roads anywhere at the present time; and the monarchs of to-day, when they wish to reach desirable places, usually travel over the same railways as do the multitude. A man must indeed have money enough to buy his ticket if he expects to remain on the train, and the would-be inventor must have brains enough to pay his passage, or he has indeed mistaken his vocation. Having the ideas,—that is, the means, to follow the simile a little further,—he would be indeed foolish to tramp across country when he might instead use the railway; and to plead unwillingness to take the trouble to learn the use of time-tables and study railway maps would be about as intelligent a proceeding in the one case as to object to learning the use of a new nomenclature and system in the other.

When the modern inventor undertakes to produce a device to order, so to speak, the usual and sensible manner of beginning is to inform himself as fully as possible of the end to be accomplished, and, unless the problem is entirely a new one, to find out what plans have been already employed by others for the same or similar purposes. Here at once the difference between the older and the later methods appears. Formerly an idea occurred to a man, and he forthwith proceeded to "complete" the invention, often entirely unaware whether or not anyone really needed such a device, and usually blissfully ignorant as to what others had already done, or failed to do, in the same field.

An instance quite in point in this respect may be given, in which an ingenious mechanic invented an elaborate apparatus for finishing at one operation a number of holes in a rather irregular casting, these holes being intended to receive the ends of wrought-iron tubes afterwards to be secured by expansion, forming steam-tight joints. When the device was submitted to the concern to which the inventor hoped to sell it, he discovered to his chagrin that the castings were so perfectly made that no finishing at all was necessary, and that the tubes could readily be expanded tightly and satisfactorily in the unfinished holes without the use of his or any other device.

In many other cases a careful examination of the field discloses the causes of failure of previous inventions, confirming again and again the trite, but too often forgotten, saying that almost as much may be learned from failures as from successes. Some day people will realize the importance, not of keeping a record of "how not to do it," but of how people have failed to do it; and, as a danger signal is placed by the hole in the ice to warn off the skater, so precautions may be taken to avoid the very thin ice in some other directions.

Our professional inventor, then, must keep himself posted as to the state of the art in which his specialties lie, always scanning closely the issues of the various patent-office publications, watching the technical journals, and generally keeping his eyes open. This branch of his profession is not unlike that of the skilful detective, in that it demands the same habit of close observation and the same exercise of a highly cultivated and available memory. It has been said " that most people observe only enough to find their way about, and to recognize their friends" ; and, although this was intended to be applied to perception in matters of art, it is none the less true in the world of mechanics. As the detective must constantly observe and remember the multitude of every-day occurrences going on all about him, never knowing what little ordinary fact may become the clue to some important event, so the man whose business it is to make inventions to order may and does train his faculties of observation and memory to an extent which sometimes appears extraordinary to the uninitiated person, as does the perception of a Sherlock Holmes in reading the really obvious meaning of a succession of quite ordinary events. This part of the work, while not really invention in any sense, forms a large portion of that record of systematized knowledge upon which the science is based, and many a professional inventor can draw from his trained memory, almost at once, data which will enable the practicability or impracticability of a proposed device to be determined. When such immediate handling of the subject is not possible, the more difficult and thorough attack upon the problem must be made. Copies of previous patents relating to the subject in hand are procured and compared, catalogues of various manufacturers are consulted, and with the field thus cleared very many of the obstacles and errors formerly inevitable are avoided. Then follows an analysis of the determinate motions which are required of the machine, these being either given conditions of the problem or directly deducible from the work or product required of it. When with these are combined the questions of the possible methods of operation and limiting features of construction, it is generally found that among the few solutions practicable the selection of the one which meets the commercial side of the case is fairly placed before the court, so to speak.

By this time drawings, first in the form of sketches, followed by calculations of stress and strain, are in order ; and the matter almost inappreciably passes from the realm of invention into the broad daylight of machine-design ; and, when the inventor finally proceeds to prepare the data for the patent attorney, he sometimes is rather uncertain as to just where the description ends and the rigid facts for the "claims" begin. Often this portion of the work involves the construction of models and the making of experiments, but these are very different from the experimenting and model-making of the old-time inventor. The man who formerly thought he had invented a flying machine proceeded to try to whittle one out and make it fly ; to-day the secretary of the Smithsonian Institution makes a series of experiments to determine the data necessary to the ascertainment of the relations of the supporting action of the air to the velocity of aero-planes, while Mr. Maxim experiments as well upon the supporting power of screws and also the problem of reducing the weight of the motor ; and these investigations, which in themselves involve no invention,—in the sense of the absolute production of something essentially novel,—will doubtless, when combined with the results of similar researches of many able investigators, make it possible to produce, in the designing-room of almost any first-class machine shop in the land, a machine which will navigate the air.

Of course there are other questions besides those of a purely mechanical nature which must enter into the success or failure of an invention. Many a device has been perfect mechanically and useless commercially for reasons of a purely business nature, and there seems to be a firmly-rooted impression in many minds that an inventor cannot possibly be a good man of business also. That idea, however, is being gradually removed, and, with his advance to the status of a professional man, the inventor has promptly grasped the business end of the situation as well. We have referred already to the poor inventor of whom we have read in so many stories, and most of us remember that in these stories there was always a grasping capitalist, and the plot nearly always hinged upon the schemes of the man of money to possess himself of the ideas of the man of brains at a trifling price, the latter individual generally being as innocent in matters of business as he was skilled in matters mechanical. The modern inventor must be a business man as well as a man of mechanical ideas ; and, in fact, the systematic methods of modern invention are really based upon the same fundamental laws as those of business, and the relation of the professional inventor to his employer to-day are much more like those of the lawyer to his client than almost any business relation we might name.

Having thus briefly glanced at the changed relations of the inventor to the public and to the world of business, and the existence of the profession of invention, properly so-called, let us examine, also very briefly, the relative importance of this profession as compared with other branches of creative industry. The subject of social economy was formerly divided into the branches of production, distribution, and consumption, and under the first head was included only what we may here call, for lack of a better name, material production. Mr. Ruskin, however, long ago pointed out, in his "Political Economy of Art," that the creations of the mind may often be far more valuable, in the most rigid commercial sense, than many products of a far greater material cost. A poor artist three hundred years ago painted some frescoes on the wall of an Italian palace, another chiseled a statue from a long-neglected block of marble, and to-day an American steamship company pays a dividend because the army of travelers from a land, then inhabited by savages, throngs across the ocean to see the remains of an art that money cannot buy nor modern training produce.

So too we may claim for the science of mechanical invention a place in the mental production of wealth of nations even greater than that of art. The systematic control of the powers of nature—a control which can only be attained by the systematic attack of the trained inventor—is adding to the wealth of the world in a proportion which will ever increase and which ultimately will exceed that from all other sources combined. Just as the leader of modern synthetic chemistry does not hesitate to predict that before a great lapse of time we shall produce in the laboratory directly from the materials of the earth all necessary and desirable food products, independently of vegetable and animal growth, so too it may safely be predicted that the other material wants of man will be attained solely by the control of natural forces, in quantity amply sufficient for the needs of all. It is only the natural perversity of man which has led him to devote the initial efforts of systematized invention towards destruction, but the enormous development of the art of war and of the materials and methods of attack and defence is in itself sufficient demonstration of the results which concentrated thought in any mechanical line can accomplish. This abnormal application of the subject is, however, only the natural historical sequence of affairs, and must work its own remedy. In the meantime it is only necessary to watch and await the results of the action of the silent but mighty forces which are being evoked in the quiet rooms where thoughtful men, trained in the art of developing mechanical ideas, are spending the best hours of their lives; and, as the coming century passes into history, the place of honor to which it will be entitled will be due, not to the men who have taught and worked destruction, but to the noble army of inventors and the mighty industries throughout all the world.

STEAMBOATS OF THE RIVER HUDSON.

By Samuel Ward Stanton.

WHEN the sun rose on August 8, 1807, its rays lit up the decks of a craft that was slowly ploughing the waters of the Hudson, somewhere above the historic Highlands in the vicinity of Newburgh Bay. Contrary to all established rules, she was moving steadily along against tide and wind. From a tall stack huge volumes of smoke poured incessantly, and the inhabitants of the houses on the banks as well as the captains and others on board of the numerous passing sloops gazed with open-mouthed wonder at the strange spectacle of what appeared to them to be moving mill-wheels on the sides of the boat.

The vessel was the steamboat Clermont. She had left the city of New York the day before at one o'clock in the afternoon, and, at a speed of nearly five miles an hour, had covered the distance between the metropolis and that part of the river through which she was passing, and this by the use of steam alone.

On board, and directing her movements, was Robert Fulton, who, while not the inventor of the steamboat, was the man to whom the world owes unquestionable gratitude, as having been the first to comprehend the great possibilities of the use of steam for propelling vessels by means of paddle-wheels, and for putting into operation the only successful steamboat that had ever been projected.

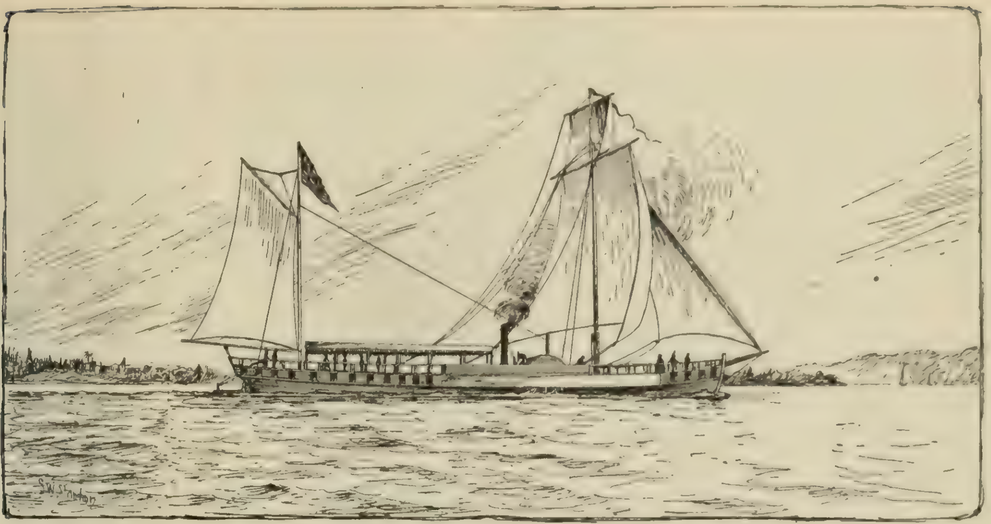
The Clermont had on board a number of Mr. Fulton's guests, and at one o'clock in the afternoon she stopped at "Clermont," the country seat of Chancellor Livingston, where she remained until the next day. The distance from New York was one hundred and ten miles, and the little boat had covered it in just twenty-four hours. On Wednesday she started from the chancellor's at nine o'clock in the morning, and arrived at Albany at five o'clock in the afternoon, the distance being forty miles. The whole trip had been made in thirty-two hours. The following morning she left Albany at nine o'clock, and went to New York in thirty hours. Fulton said, in an account of the trip: "No advantage could be derived from my sails. The whole voyage has therefore been performed by the power of my steam-engine."

On her first trip up the river as a packet-boat there were twenty-four passengers on board; she continued to carry a good passenger list on every trip throughout the season. During the following winter the Clermont was made longer and broader; with her name changed to

·PROMINENT·HUDSON·RIVER·STEAMBOATS·1807-1895·

Compiled & Arranged by S·W·Stanton

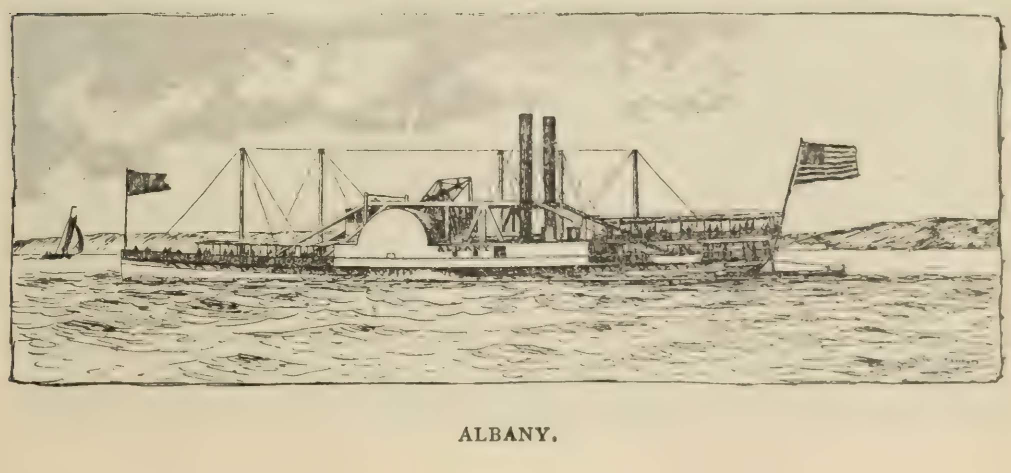
NAME	BUILT	CONSTRUCTED BY	AT	TONNAGE	LENGTH	BREADTH	DEPTH	ENGINE BUILT BY	DIAMETER CYLINDER	LENGTH STROKE	ROUTE	REMARKS
CLERMONT	1807	Charles Brown	New York	-	133'	18'	7'	Boulton & Watt	24"	4'	N.Y. and Albany	Lengthened 1808 and name changed to [illegible]
CAR OF NEPTUNE	1808	do	do	295	175	24	8	-	33	4' 4"	do	Broken up
PARAGON	1811	do	do	331	173	27	9	-	32	4'	do	Struck a rock and sunk near Albany
HOPE	1811	-	-	280	-	-	-	Robert McQueen	-	-	do	Had mate in PERSEVERANCE, both broken up
FIRE FLY	1812	Charles Brown	New York	118	100	19	7	-	20	3' 9"	N.Y. and Newburgh	Broken up
LADY RICHMOND	1813	-	-	370	-	-	-	-	-	-	N.Y. and Albany	Broken up about 1830
OLIVE BRANCH	1815	-	-	295	122	30	-	-	40	5	do	Built for N.Y. and New Brunswick route, broken up
CHANCELLOR LIVINGSTON	1816	Henry Eckford	New York	495	157	33½	10	James P. Allaire	44	5	do	Placed on L. Sound 1825, [illegible]
UNITED STATES	1821	J. Williams	do	180	140	-	-	-	-	-	do	N.Y. & New Haven route, afterwards towboat on Hudson
JAMES KENT	1823	Blossom, Smith & Dimon	do	364	140	48	-	-	-	-	do	Stake boat on North River 1894
CONSTITUTION	1825	Brown & Bell	do	275	145	27	-	-	42	9	do	Altered into towboat named [illegible], broken up
CONSTELLATION	1825	do	do	275	149	27	-	-	44	10	do	Dismantled and engine taken to Lake Erie
COMMERCE	1825	C. Bergh	Brooklyn	371	130	24	8½	-	16 & 30	4	do	Altered 1852, and named ONTARIO, broken up 1894
SWIFTSURE	1825	do	do	265	130	24	8½	-	16 & 30	4	do	Altered into towboat, broken up
NEW PHILADELPHIA	1826	-	-	300	170	24	-	-	55	10	do	Altered into towboat, broken up
INDEPENDENCE	1827	Brown & Bell	New York	368	148	26	-	-	44	10	do	Altered into towboat, broken up
ALBANY	1827	J. Vaughn	Philadelphia	298	212	26	9	-	65	9	do	Lengthened 1839 to 289 feet, broken up
NORTH AMERICA	1827	William Capes	New York	497	218	30	8	-	44	8	do	Two beam engines, sunk by ice 1839
VICTORY	1827	M. Kenyon	Albany	290	-	-	-	-	-	-	do	Altered into towboat, sunk 1845
DE WITT CLINTON	1828	do	do	571	233	28	10	-	66	10	do	Twice enlarged, broken up
OHIO	1829	-	-	412	192	30	-	-	60	9	do	Broken up
NOVELTY	1830	William Brown	Hyde Park	450	165	24	9	-	30	6	do	Lengthened to 220 feet, 2 engines, 12 boilers, [illegible]
ERIE	1832	Brown & Bell	New York	471	180	28	9	West Point Foundry	44	10	N.Y. and Troy	Two engines, 4 smokestacks, engines placed in TROY
CHAMPLAIN	1832	do	do	471	180	28	9	do	42	10	do	Mate to ERIE; broken up
WESTCHESTER	1832	Smith & Dimon	do	230	-	-	-	-	-	-	N.Y. and Albany	Altered into towboat named [illegible], broken up
ROBERT L. STEVENS	1835	-	Kingston	298	175	24	-	-	36	10	do	Broken up, engine placed in [illegible]
HIGHLANDER	1835	Lawrence & Sneden	New York	313	175	24	8	West Point Foundry	41	10	N.Y. and Newburgh	Went to Delaware River, broken up
SWALLOW	1836	William Capes	Brooklyn	426	224	22	7½		46	10	N.Y. and Troy	Lost April 7, 1845, over 100 persons perished
ROCHESTER	1836	Smith & Dimon	New York	491	209	24	8½	West Point Foundry	43	10	N.Y. and Albany	Broken up
UTICA	1837	William Capes	Brooklyn	340	180	21½	8⅓	do	43	10	do	Altered into towboat, condemned 1875
BALLOON	1839	Devine Burtis	do	204	160	18	7½	James Cunningham	28	11	Po'keepsie & Albany	Broken up on Delaware River
NORTH AMERICA	1839	-	-	494	230	26	9	James Cunningham	48	11	N.Y. and Albany	Broken up at New Orleans
SOUTH AMERICA	1840	-	-	638	260	26	9¼	do	54	11	do	Broken up, engine placed in BERKSHIRE
TROY	1841	-	Brooklyn	724	294	61	-	West Point Foundry	44	10	N.Y. and Troy	Engines from ERIE placed horizontally, broken up
EMPIRE	1843	-	-	936	-	-	-	W.A. Lighthall	-	-	do	In collision July [illegible] 1853, broken up
NIAGARA	1844	George Collyer	New York	688	265	28½	9¾	Hogg & Delamater	60	11	do	Altered into towboat, running 1894
IRON WITCH	1844	Hogg & Delamater	New York	-	225	27	13	do	-	-	N.Y. and Albany	Name changed to ERIE, made barge, broken up
RIP VAN WINKLE	1845	George Collyer	do	534	242	25	8	W. A. Lighthall	50	10	do	Wrecked at Albany, April 16 1872
HENDRICK HUDSON	1845	-	-	1170	320	35	9½	-	72	11	do	Broken up
OREGON	1845	-	-	1050	330	35	10	Stillman, Allen & Co	72	11	do	Lost
THOMAS POWELL	1846	Lawrence & Sneden	New York	585	231	28	9	T.F. Secor & Co	48	11	N.Y. and Newburgh	Broken up
ISAAC NEWTON	1846	William H. Brown	do	1332	338	40	10⅔	Allaire Works	81½	12	N.Y. and Albany	Lengthened 1854 to 405 feet, burned Dec 5 1863
ALIDA	1847	do	do	640	265	30	10	Henry R. Dunham & Co	56	12	do	Altered into towboat, broken up
ARMENIA	1847	Thomas Collyer	do	398	185	28	8	do	40	14	do	Went to Potomac River 1883, burned [illegible]
NEW WORLD	1847	William H. Brown	do	1418	385	35	11	T.F. Secor & Co	76	15	do	Engine put in ST. JOHN, broken up
FRANCIS SKIDDY	1852	George Collyer	New York	1235	322	38	11½	Jas. Cunningham & Co	71	14	do	Wrecked Nov 5 1864, engine in DEAN RICHMOND
DANIEL DREW	1860	Thomas Collyer	do	880	251	30	9¼	Neptune Iron Works	60	10	do	Burned August 29 1886
JAMES W. BALDWIN	1861	M.S. Allison	Jersey City	710	242	34	9	Fletcher, Harrison & Co	60	11	N.Y. and Rondout	Lengthened to 273 feet, running 1894
MARY POWELL	1861	do	do	983	260	34½	10¼	do	72	12	do	Lengthened to 300 feet, running 1894
THOMAS CORNELL	1863	E.S. Whitlock	Brooklyn	1256	310	34	-	-	72	12	do	Wrecked March 27 1882
BERKSHIRE	1863	Morton & Edmonds	Athens	-	253	37	10	James Cunningham	54	11	N.Y. and Hudson	Burned June 8 1864, 40 persons lost
ST. JOHN	1863	John Englis	Brooklyn	2645	420	51	10	T.F. Secor & Co	76	15	N.Y. and Albany	Longest boat that ever ran on river, burned Jan 29 1885
CHAUNCEY VIBBARD	1864	Lawrence & Sneden	do	1158	281	35	9	Fletcher, Harrison & Co	62	12	do	Excursion boat on Delaware River 1894
DEAN RICHMOND	1864	John Englis	Greenpoint	2525	348	46	10	Jas. Cunningham & Co.	75	14	do	Running 1894
NUPHA	1865	J.S. Baldwin	New Baltimore	1232	253	37	10	Fletcher, Harrison & Co	37	5	N.Y. and Hudson	Propeller, running as METROPOLITAN 1895
DREW	1866	John Englis	Greenpoint	2902	366	47	10				N.Y. and Albany	Largest tonnage of any H.R. boat, running 1894
CITY OF TROY	1876	do	do	1527	300	36	10		60	12	N.Y. and Troy	Running 1894
SARATOGA	1877	do	do	1438	300	36	10	T. F. Secor & Co	60	12	do	Running 1894
CITY OF CATSKILL	1880	Van Loan & Magee	Athens	-	250	35	10	W. & A. Fletcher	56	12	N.Y. and Catskill	Burned February 1883
ALBANY	1880	Harlan & Hollingsworth Co.	Wilmington, Del	1415	295	40	11½	do	73	12	N.Y. and Albany	Lengthened 1893 to 325 feet, running 1894
KAATERSKILL	1882	Van Loan & Magee	Athens	1361	281	38	10	do	63	12	N.Y. and Catskill	Running 1894
CITY OF KINGSTON	1884	Harlan & Hollingsworth Co.	Wilmington	1117	250	33½	12½	Harlan & Hollingsworth Co	30 & 56	3	N.Y. and Rondout	Propeller, sold 1889 for service on Pacific Coast
NEWBURGH	1886	Neafie & Levy	Philadelphia	1033	210	32	12½	Neafie & Levy	26 & 45	3	N.Y. and Newburgh	Propeller, running 1895
HOMER RAMSDELL	1887	T.S. Marvel & Co	Newburgh	1181	212	32½	11	William Wright	28 & 52	3	do	Propeller, lengthened [illegible] to 237 feet, running 1895
NEW YORK	1887	Harlan & Hollingsworth Co.	Wilmington	1552	311	40	12¼	W. & A. Fletcher	75	12	N.Y. and Albany	Running 1894



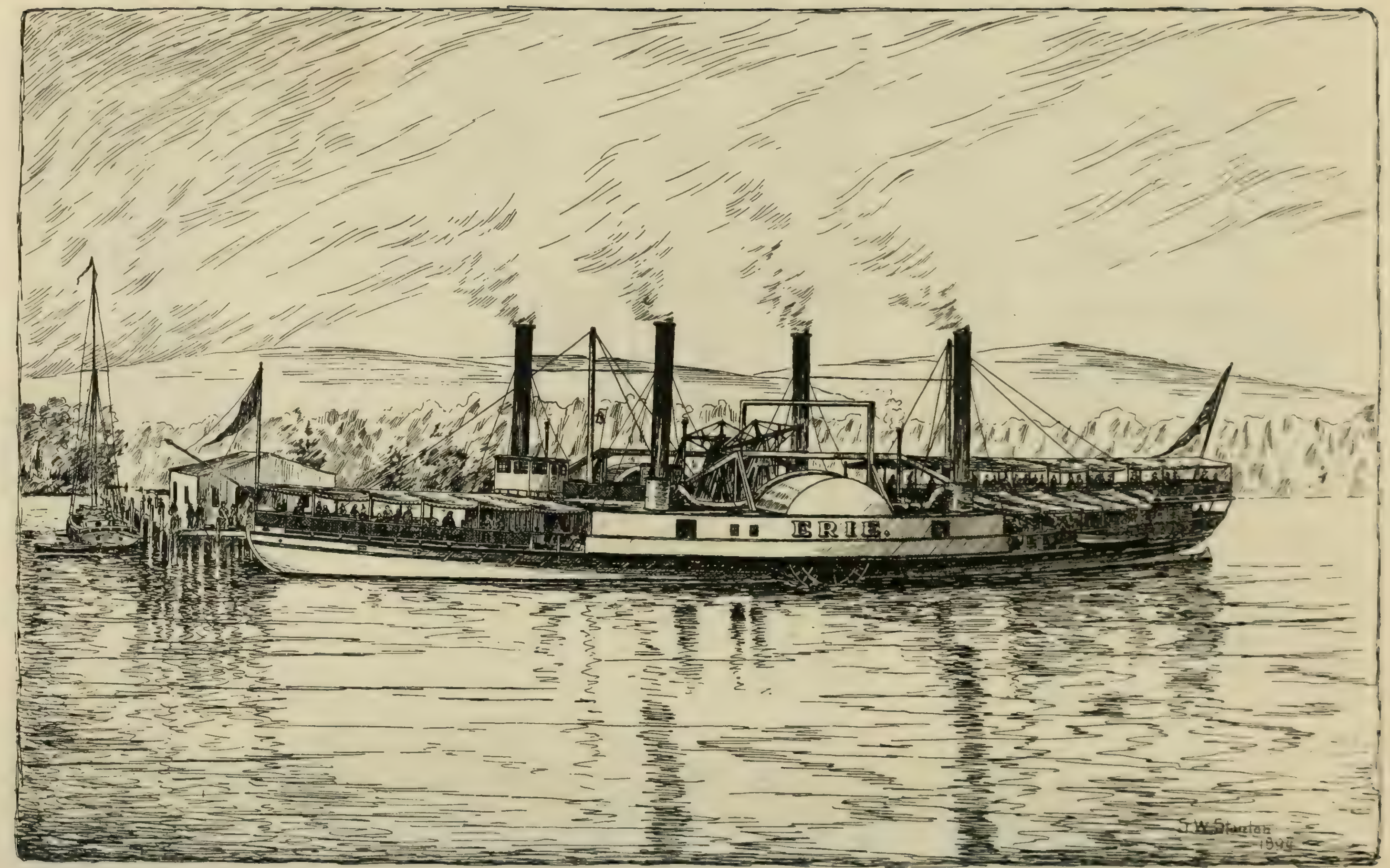
PARAGON.

North River, she began her trips again in the spring, and for several years was used continuously. In the New York *Evening Post* of November 9, 1809, the following appeared: "The North River steamboat arrived this afternoon in twenty-seven and one-half hours from Albany, with sixty passengers."

Travel by steamboat becoming so popular that the Clermont could not accommodate the crowds that desired to avail themselves of this mode of conveyance, a new boat was contracted for. This was the Car of Neptune, built in 1807–8 by Charles Brown. These two boats were able to perform the work satisfactorily for several years. In 1811 the Paragon appeared; she was two feet shorter than the Car of Neptune, but was of greater beam and larger tonnage. Two opposition steamboats, the Hope and Perseverance, were placed on the river in 1811, but were forced to withdraw from the business on account of the exclusive privilege given to the Fulton and Livingston Line to navi-



ALBANY.

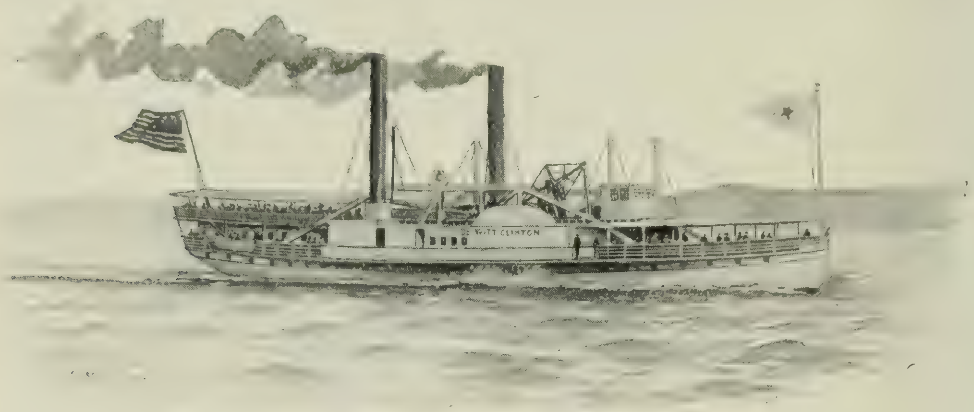


ERIE.

CLERMONT.

gate the waters of New York State. Following the Paragon, of the regular line, came the Fire Fly, a small boat, built for the lower river trade, in 1812, after which came the Lady Richmond, one of the best boats that had yet been constructed.

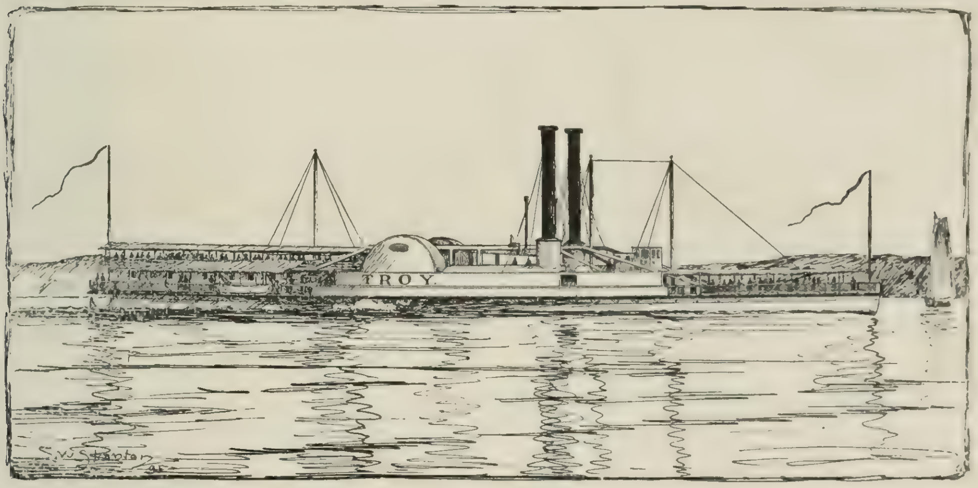
In 1816 appeared the Chancellor Livingston, an important Hudson River boat and the most wonderful steam vessel of early times. She was designed by Mr. Stoudinger, a naval architect of no mean ability at that date, and was gotten up regardless of cost. Her hull was constructed by Henry Eckford, and the joiner-work executed under the direction of David Cook. The engine, by James P. Allaire, was undoubtedly the finest that had yet been constructed in this country, and the boiler—of copper, and weighing about forty-four thousand pounds—was of a new model. She was the first steamboat having a cabin on the main deck, with a promenade above, and her total cost was $11,000. She was much the speediest of the river boats, and on her trial trip, which occurred Saturday, March 29, 1817, she ran to Newburgh, a distance of sixty miles, "in a few minutes less than nine hours, of which time the tide was in her favor only three hours. In returning, the same distance was run in eight hours and fifteen minutes, the greater part of the time against a flood tide and south wind." The calculations were that she would go to Albany in about twenty hours. On December 5, 1817, she went up in eighteen hours. The Livingston continued to ply on the Hudson until 1828, when she was placed on the Long Island Sound route from New York to Providence.



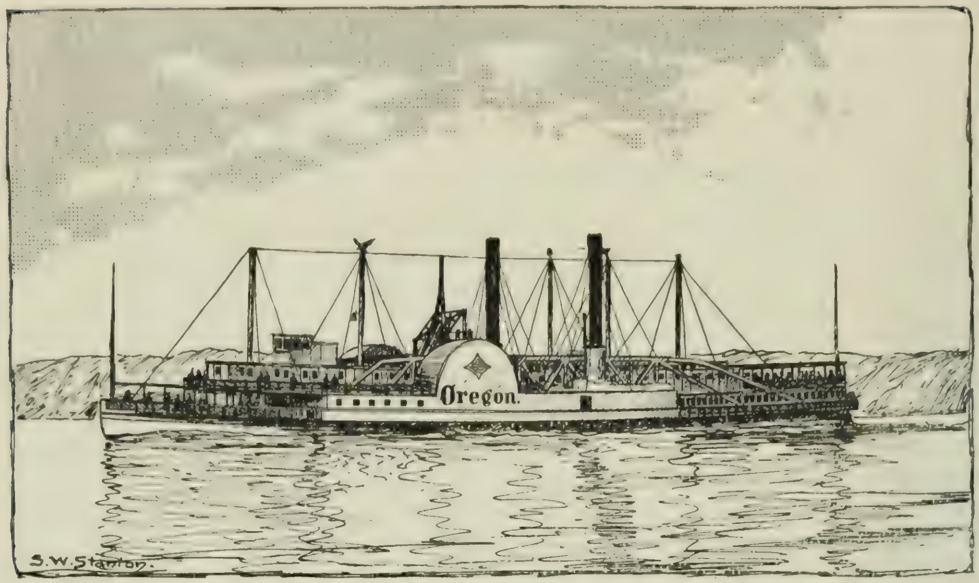
DE WITT CLINTON.

The North River—or Clermont—having been laid aside, these boats ran as regular packets up and down the river, to the exclusion of all others, the Fulton & Livingston Company having the sole right to navigate the waters of New York State by steam. In June, 1821, however, a new boat, called the United States, and built by William Gibbons, was put on the route from Perth Amboy, N. J., to Albany, making stops at New York and the Hudson River towns. After a few trips she was compelled by law to stop running, and she was put on the New Haven route, where she ran many years.

The last steamboat built by the old North River Steamboat Company, the James Kent, appeared in 1823. She was thus described in the New York *Statesman* of August 14, 1823: "Yesterday afternoon we had the pleasure of visiting the new and beautiful steamboat, James Kent, now lying at the foot of Liberty street. Her frame is composed entirely of live oak, locust, and cedar. She is copper-fastened, and secured in an extraordinary manner by screw-bolts. She was built by Messrs. Blossom, Smith & Dimon, who have certainly done themselves great credit by this elegant specimen of naval architecture. Her machinery is on a scale so gigantic as apparently to require the anvils, hammers, and sinewy arms of Vulcan and Cyclops to forge its massy wheels, bolts, and bars. The boiler is of copper, unusually thick and strong, weighing upwards of thirty tons, and amounting to nearly one-third of the whole expense of the boat. It is planned in such a manner that, if it should happen to burst, the water would immediately be carried through the bottom of the vessel by means of cast-iron tubes, or hollow pillars. The copper was manufactured by the Soho Company. The engine is modelled after the latest and most approved plan of the celebrated Mr. Watts, and was manufactured by the West Point Foundry. It is decidedly one of the finest engines that has yet been made in America, both as to the quality of the castings and the scientific arrangement of the machinery. It occupies an unusually small space, and the workmanship is highly creditable to the manufacturers of our country. The James Kent is finished in a style to comport with the superiority of her essential parts. Few rooms in a



TROY.



OREGON.

private dwelling surpass her cabins in point of finish, neatness, and elegance, or in richness of furniture.

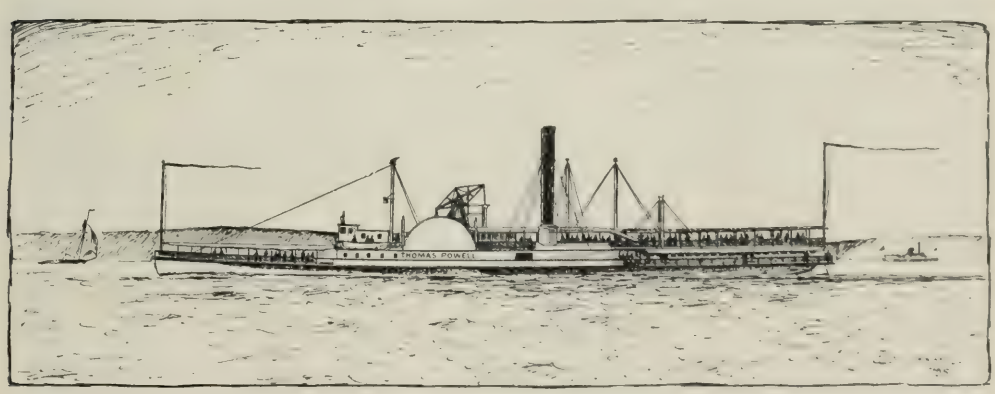
"The gentlemen's dining-cabin is spacious, airy, and lighted by eight or ten windows above, which may be opened or closed, as the weather may require. A table is extended in a semicircular form quite around the room, nearly into the center of which the stairway leads. The ladies' cabin and drawing-room, the former below and the latter on the deck, exceed in splendor and elegance the gentlemen's apartment. In the sitting-room the curtains are of blue damask, with orange drapery; in the dining-cabin the curtains are embossed crimson moreen, with blue vallons and richly-wrought fringe. The tables are mahogany, and the chairs and settees of birdseye maple, with cane bottoms. The mirrors and other furniture are equally splendid." . .

She proved of greater speed than even the Chancellor Livingston. On Monday, May 31, 1824, the James Kent made a remarkably quick passage for those days. She left New York at 5:15 in the morning, and reached Albany at 7:45 at night, having made the passage in fourteen and a half hours, including ten landings. The hull of this boat is still in existence; it is anchored off the Elysian Fields, Hoboken, being used as an anchorage for the tows of the Cornell fleet of boats that arrive and depart from that neighborhood. It is without doubt the oldest hull of a steam vessel in existence to-day.

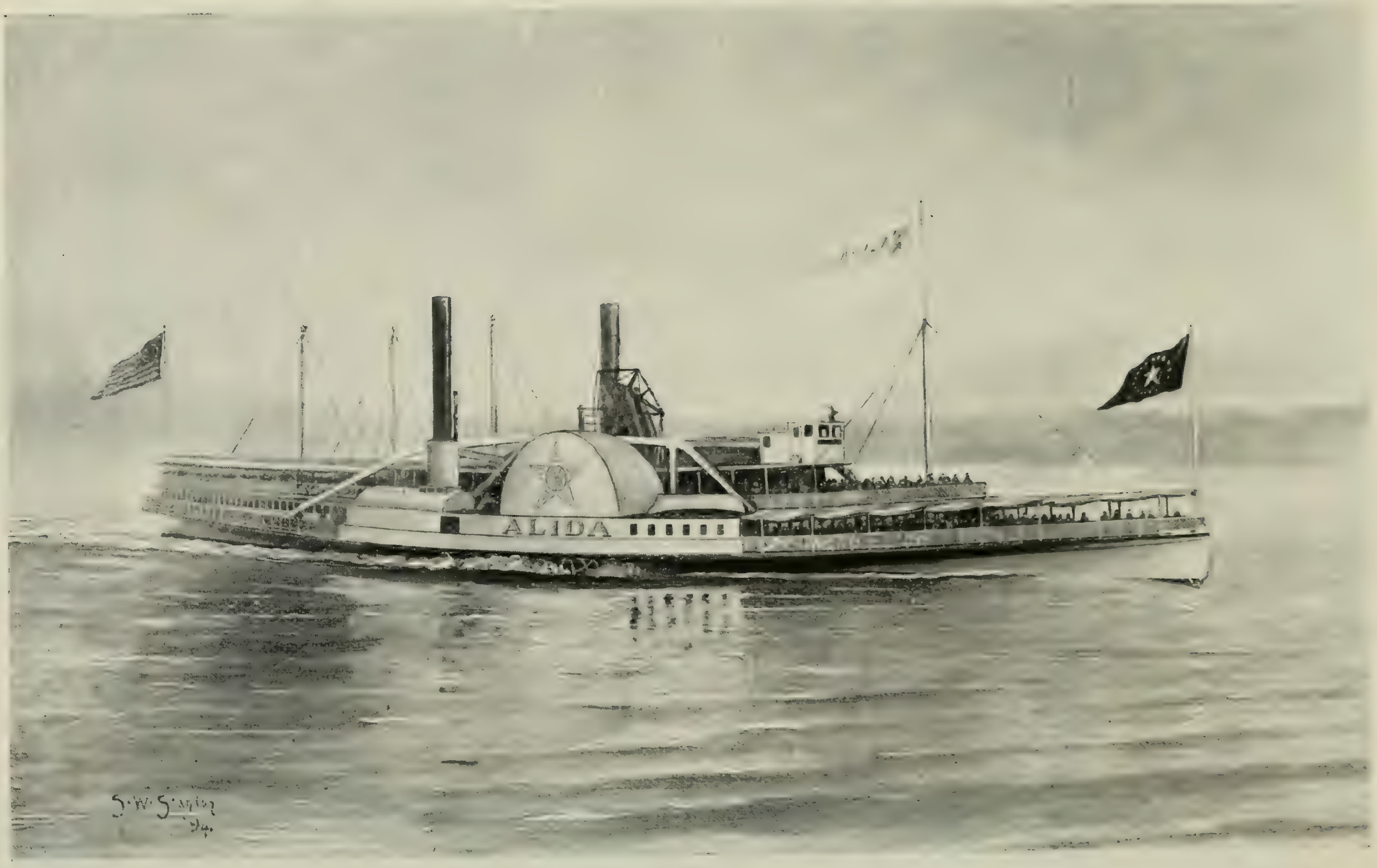
It was in 1824 that the famous steamboat Olive Branch appeared on the scene,—a boat whose owners broke the monopoly of steam navigation so long enjoyed by the Fulton & Livingston Line. She was placed on the New York and Albany route as an independent packet, and, in spite of all attempts on the part of the old line to drive her off, she continued to run regularly. In June a decision was reached by the supreme court of the United States and the chancellor of New York State whereby the navigable waters of the country became a free field for all vessels propelled by steam. The Olive Branch was built in 1815, for the New York and New Brunswick route (Philadelphia line), and was a staunch and first-class steamer for her day.

During 1825 many new steamers were placed on the river, all of them being used as passenger boats. The largest and best were the Constitution and Constellation. These two boats were beautifully fitted up, and were not surpassed for comfort or convenience by any for many years. Numerous explosions having taken place on American steamboats during these early days, many persons were exceedingly wary about patronizing vessels propelled by steam. A company was formed in 1825 which had constructed two steamboats and two passenger barges,—the latter termed "safety barges,"—and these ran on the river for a number of years. The steamboat Commerce towed the Lady Clinton, and the Swiftsure the Lady Van Rensselaer, the barges being fastened to the stern of the steamer by means of a bridge, or gang-way, over which the passengers were allowed to pass.

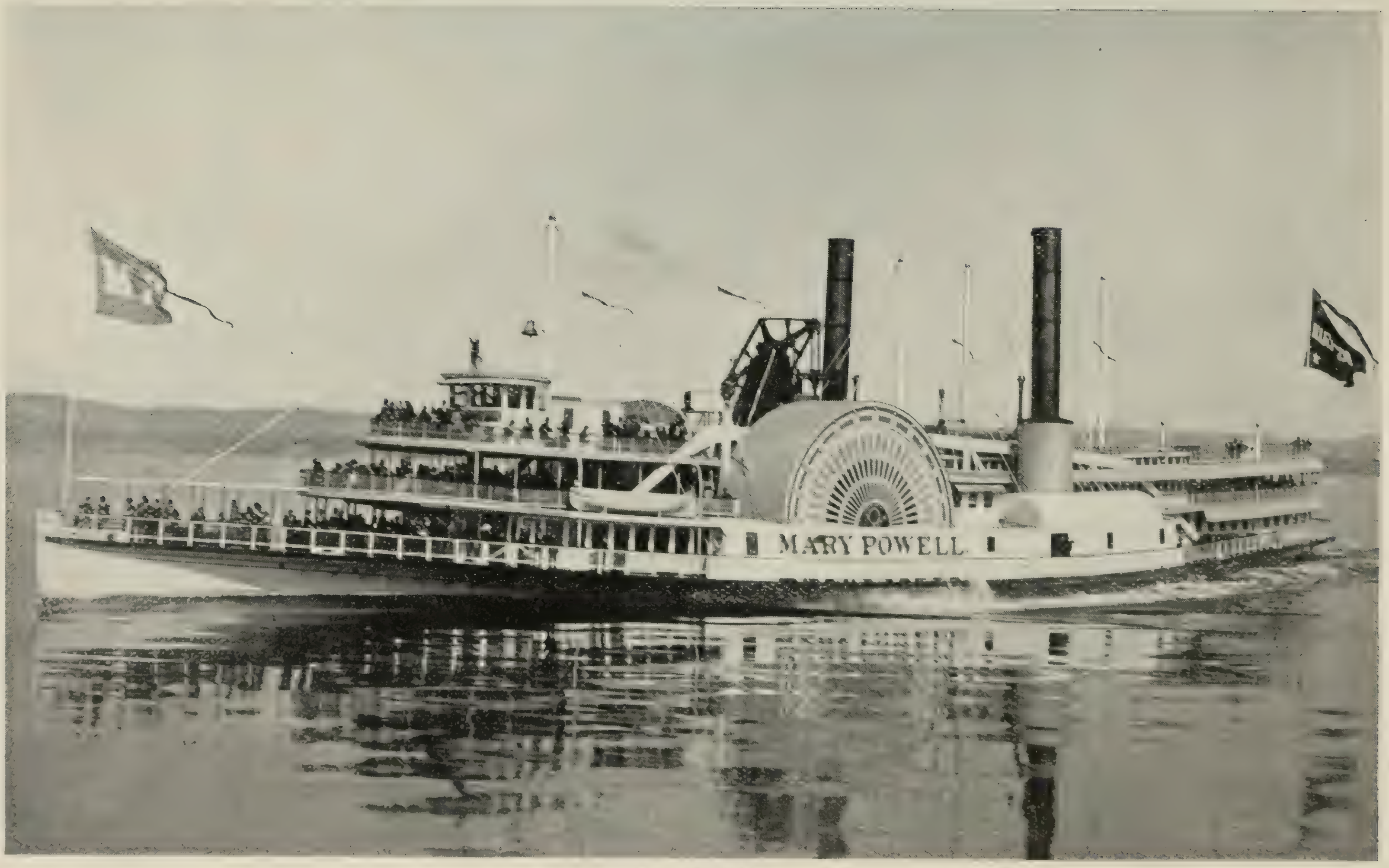
It was in 1826, when the residents along the river were enjoying the advantages of numerous steamboat lines and cheap transportation, that the Messrs. Stevens placed on the river the New Philadelphia, the forerunner of that type of Hudson river steamboat that remained a feature ever after. Her boilers were placed on the guards, aft of the wheels, and her beam engine had many improvements. During the following year the Albany came out, followed by the North America, the latter having the novelty of two beam engines. During 1827–8 the Victory and the De Witt Clinton, two very fine boats, built after the Stevens plan, were constructed at Albany and placed on the river. They were soon purchased by the Stevens line, and for many years this com-



THOMAS POWELL.



ALIDA.



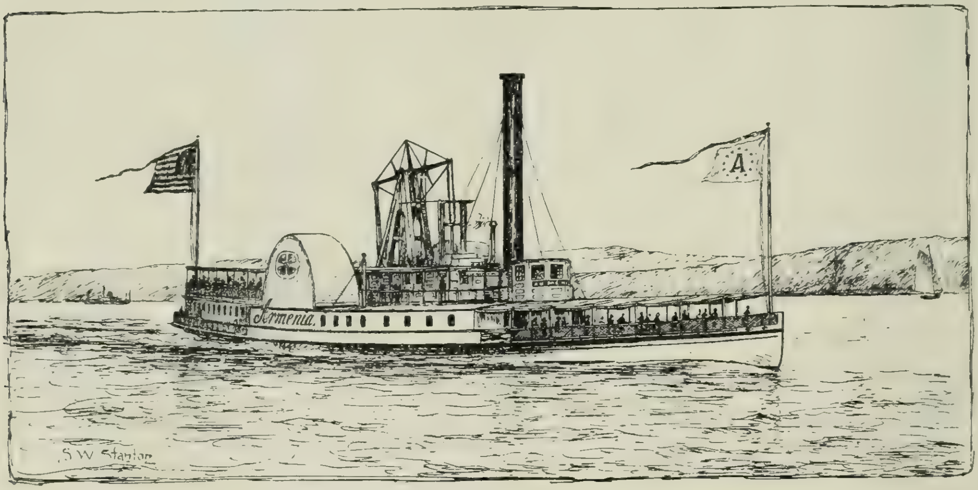
MARY POWELL.

pany enjoyed the almost exclusive monopoly of passenger traffic on the Hudson.

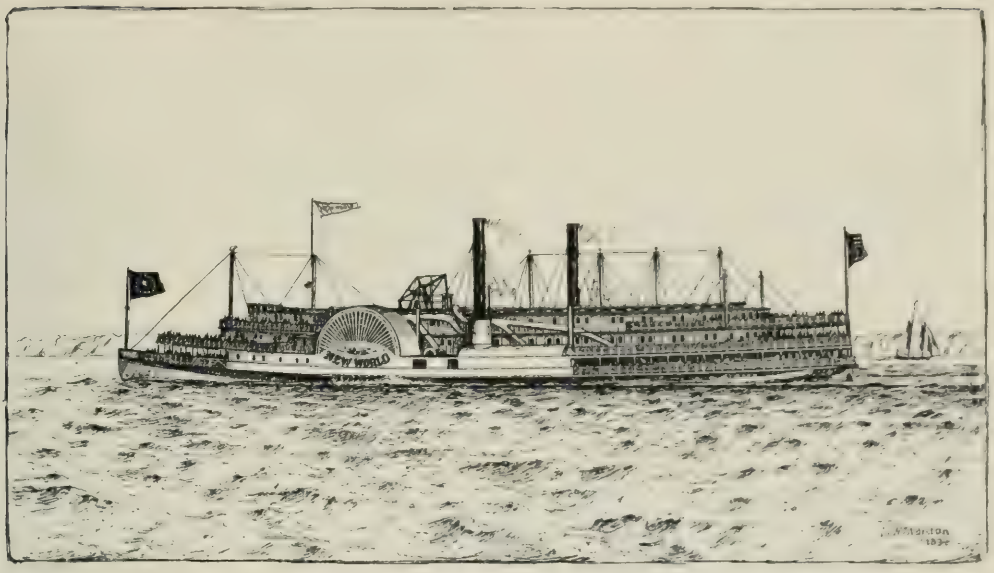
The Novelty, in 1830, was distinguishable as the first steamboat with tubular boilers. In 1832 two large and finely finished steamboats were constructed for the day line. They were the Erie and Champlain, and each boat carried four smoke-stacks and was propelled by two beam engines. These steamboats, like all others of the time, burned wood, and from thirty-five to forty cords were used on the run between New York and Albany. One of the most famous of the early "flyers" of the river was the Swallow, built in 1835.

In that year a new line was started, its establishment growing out of the complaints of the travelling public at the exorbitant rates and other abuses practised by the Hudson River Association, then running the largest fleet and the best boats on the river. The new line was called the "People's Line," and as a proof of its fine management it may be stated that it is still in existence,—the main line between the cities of New York and Albany at the present time. The line was started by Daniel Drew, Capt. St. John, and several others, and their first steamers were the Emerald and Westchester, two purchased boats. The line so quickly grew in popularity that two steamboats were immediately contracted for. These were the Rochester and Utica, which appeared in 1836 and 1837, respectively. The Rochester was the fastest boat that had ever appeared on the river. On June 14, 1837, she made the run from New York to Albany in ten hours and one minute. The Highlander, a smart boat, whose only rival was the Rochester, was built in 1835 for the Newburgh Line.

In 1840 two new steamboats, the North America and South America, were added to the People's Line, and Isaac Newton and his associates



ARMENIA.



NEW WORLD

joined the company. These two vessels were the largest and finest that had yet been built; for many years no vessel could approach in speed the South America. On these boats Isaac Newton successfully introduced the burning of anthracite coal, by which the expense of fuel was reduced at least fifty per cent. below that of the wood-burning boiler. The South America, upon her appearance, was universally acknowledged to be the peer of anything that had ever been put afloat. She was designed by Isaac Newton and James Cunningham. Previous to the building of the North and South America, Newton had designed and had had constructed the famous little river steamer Balloon, a remarkably swift vessel. Her beam engine was the first with long connections, thus allowing her the use of wheels of large size.

The Old Line then built the Troy (1841), the Empire (1843), and the Niagara (1844); the Niagara is still in existence, being used as a towboat. The first iron-hulled steamboat built for the navigation of the Hudson was the Iron Witch (1844),—the only large boat of iron that ran on the river until the advent of the Albany (1880).

The Oregon (1845), having a speed of over twenty miles an hour, was a perfect river steamer in all respects. The famed New World (1847) was one of the fastest steamers ever built in America; her engine had the enormous piston stroke of 15 feet. On her famous run in 1852, she left New York at 7:10 A. M., made nine landings, each averaging five minutes, and reached Albany at 2:15 P. M., the actual running time being six hours and twenty minutes.

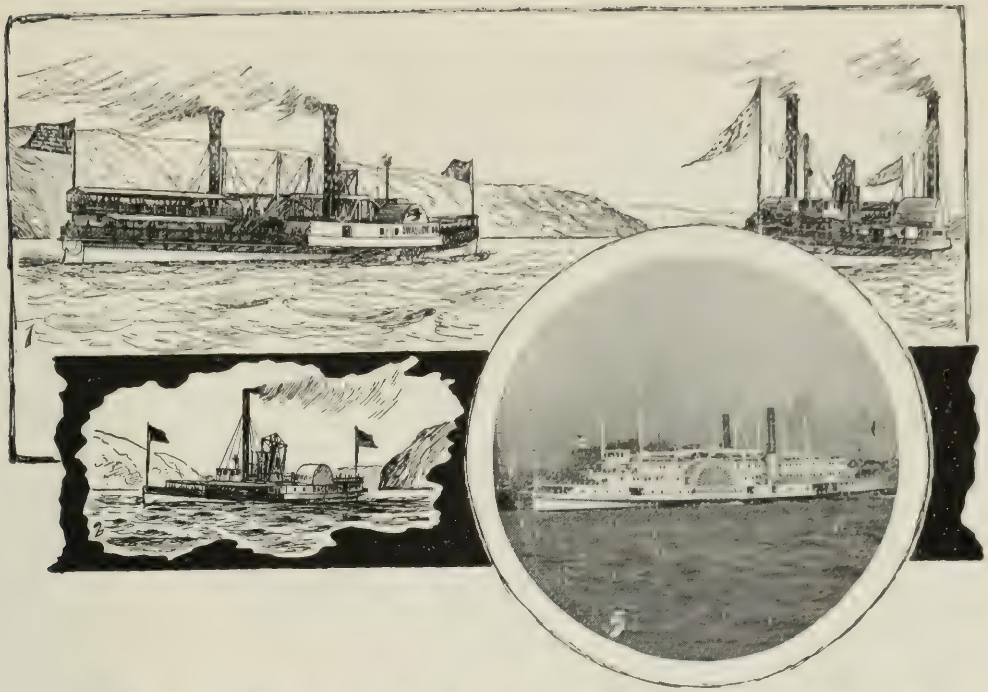
The Thomas Powell, for the Newburgh line, and the Alida, for the day route to Albany, were fine and fast steamers, with a speed of over twenty miles an hour. The Armenia was a smaller boat, but of excellent model and good speed. In 1852 the last of the great day boats of the early times appeared. This was the Francis Skiddy. It may safely be said that for finish of hull and beauty of lines this boat was the culminating point in Hudson River steamboat building; the art could progress no further.

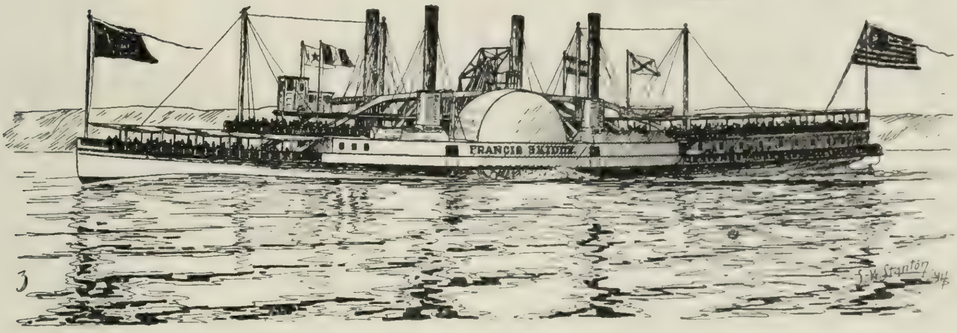
The Reindeer and Henry Clay, two medium-sized steamboats, appeared the same year as the Francis Skiddy, and could hold their own in speed with anything on the river. The Henry Clay was burned while racing with the Armenia on July 28, 1852, and sixty of her passengers lost their lives.

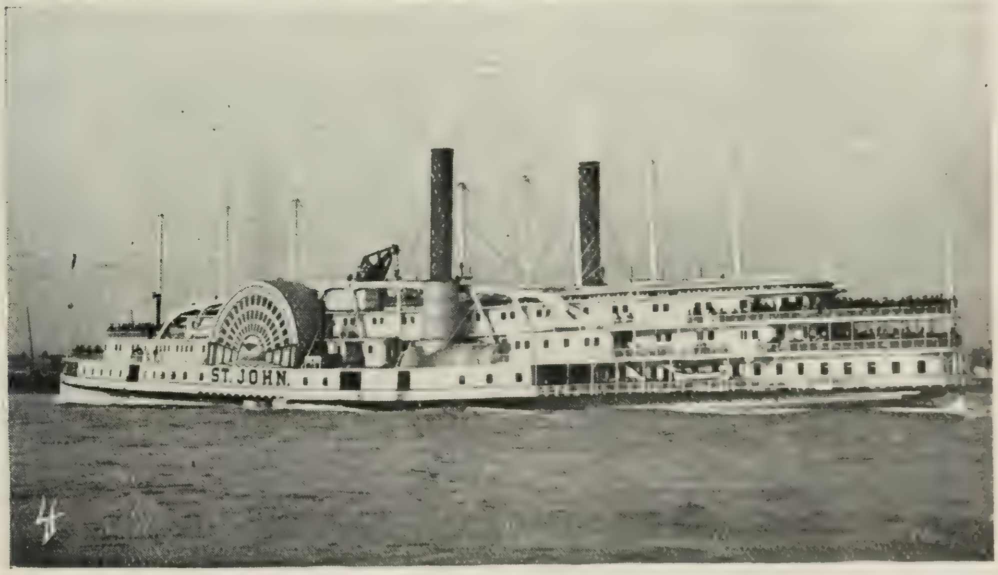
In 1855 the New World and Isaac Newton, built originally for the day line, but which had been for some time unemployed, were changed into night boats. The rebuilding of these vessels was the first step towards those great river palaces—veritable floating hotels—for which America, and especially the Hudson River and Long Island Sound, has become famous. Heretofore the saloons had been but single decks in height; now these vessels appeared with great saloons, with galleries around them, double tiers of staterooms, almost unlimited passenger accommodations, and conveniences unthought of. The New World, when finished, was twelve feet broader than before, and the Isaac Newton was sixty feet longer. The grand saloons of these boats were for many a day the great "show-pieces" of interior steamboat architecture in this country. A feature was the lighting of the saloons with gas. The order of architecture on the Isaac Newton was Gothic, while that of the New World was Corinthian. The Francis Skiddy, of the New York and Troy line, also underwent similar changes, and became a great night boat.

ALBANY.

In 1860 a new boat was added to the day line,—the Daniel Drew, which became widely known as the fastest boat then on the river. Her hull was a model of symmetry and grace. On October 13, 1860, she ran to Albany in seven hours and twenty minutes, or, deducting the







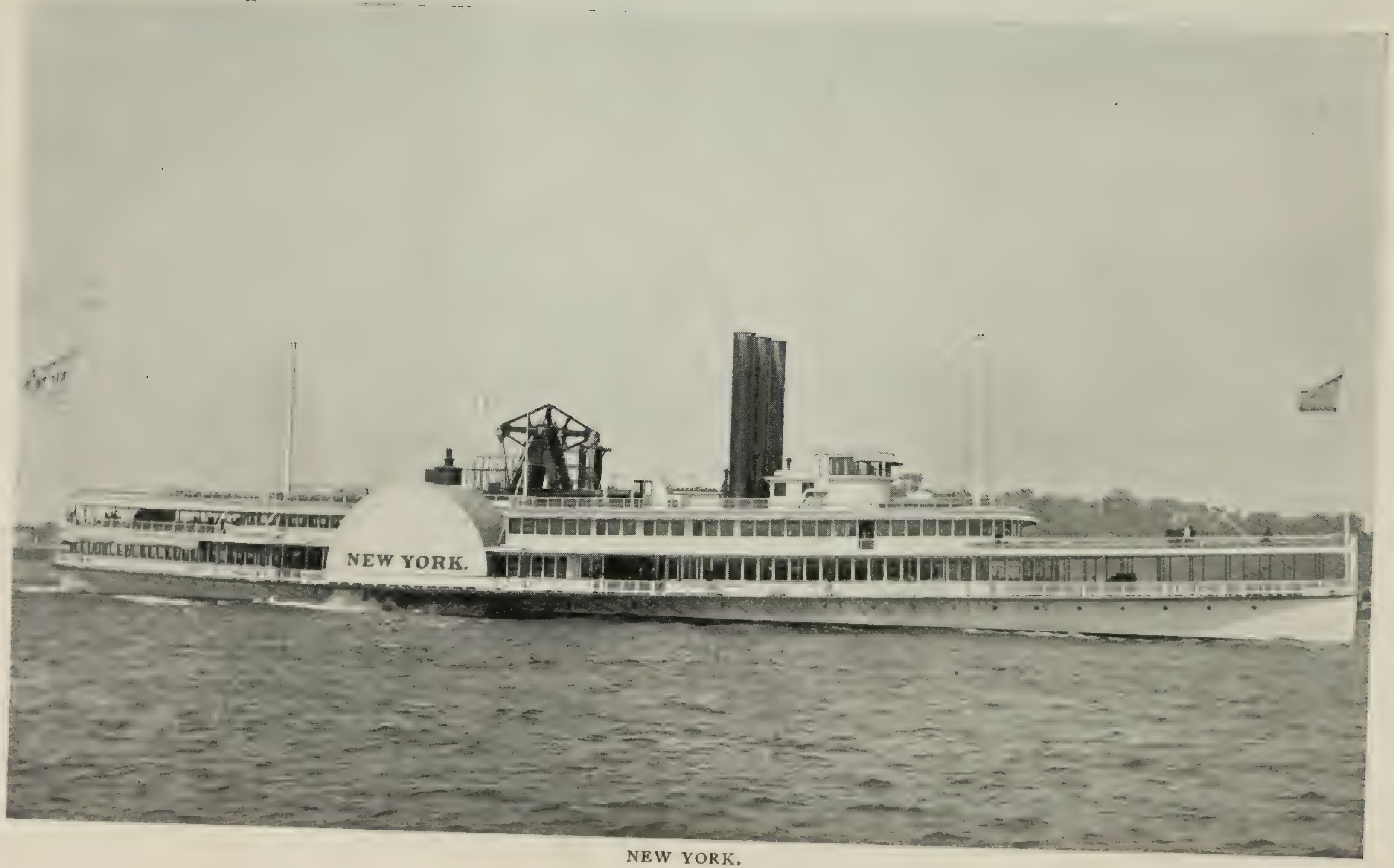
1 SWALLOW. 2 BALLOON. 3 FRANCIS SKIDDY. 4 ST. JOHN. 5 SARATOGA.

KAATERSKILL.

time lost at the five landings, six hours and fifty minutes,—thus maintaining an average speed of twenty-two miles an hour throughout the trip.

In 1861 a boat was placed on the Hudson that was destined to become the most popular river steamer ever in American waters. This was the world famous Mary Powell, "Queen of the Hudson," which made some of the quickest passages on record, being able to steam up to twenty-five miles an hour. In 1881 she made her fastest time between New York and Rondout, her regular route, leaving New York at 3:33 P. M., and arriving at Rondout at 7:45. The distance is ninety-two miles.

C. VIBBARD.



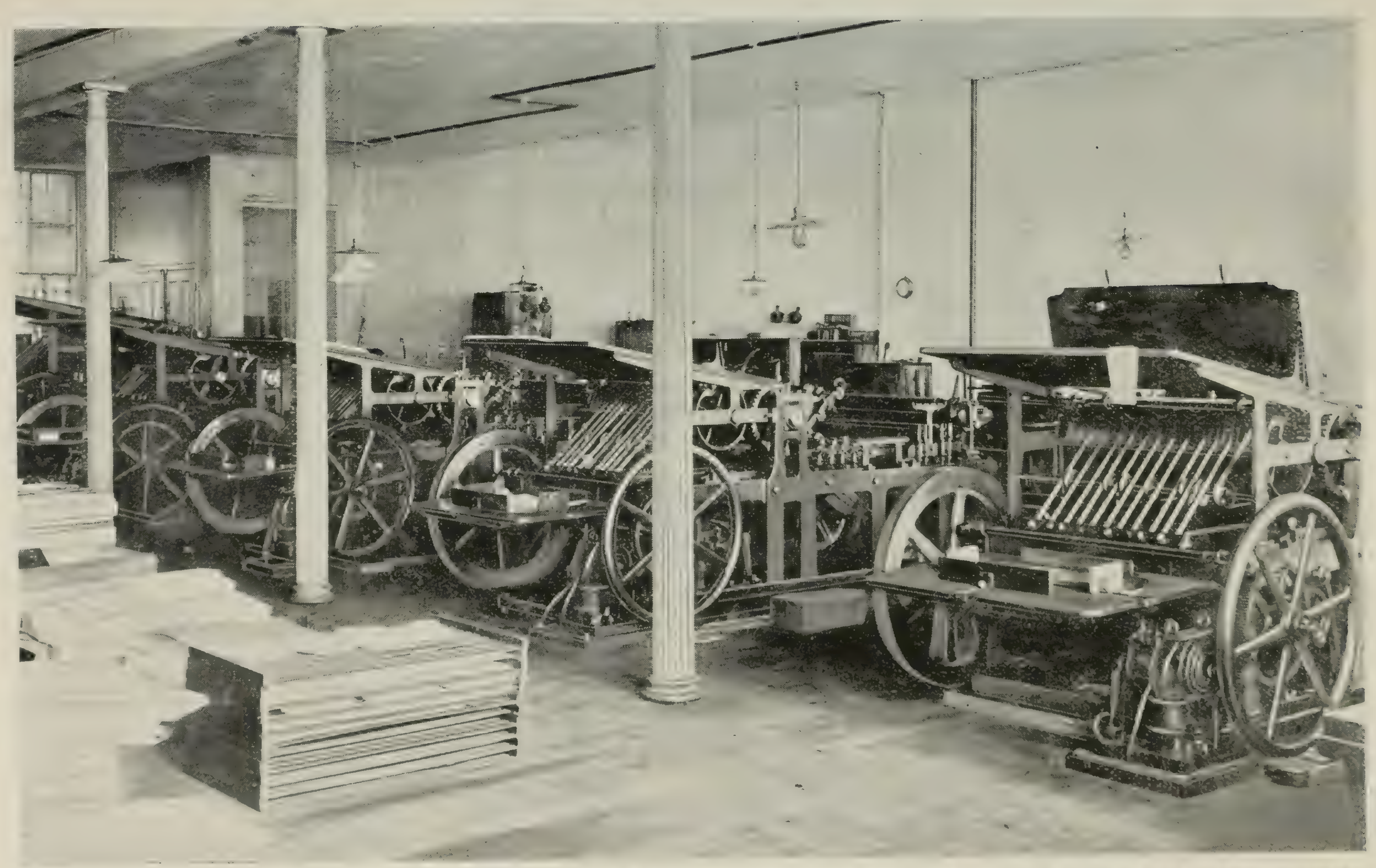
NEW YORK.

Three wonderful river boats were set afloat in 1863, 1865, and 1866. They were the St. John, Dean Richmond, and Drew, respectively, and they were built for the People's Line. The general plan of the rebuilt New World and Isaac Newton was followed in the new boats, only on a larger and finer scale.

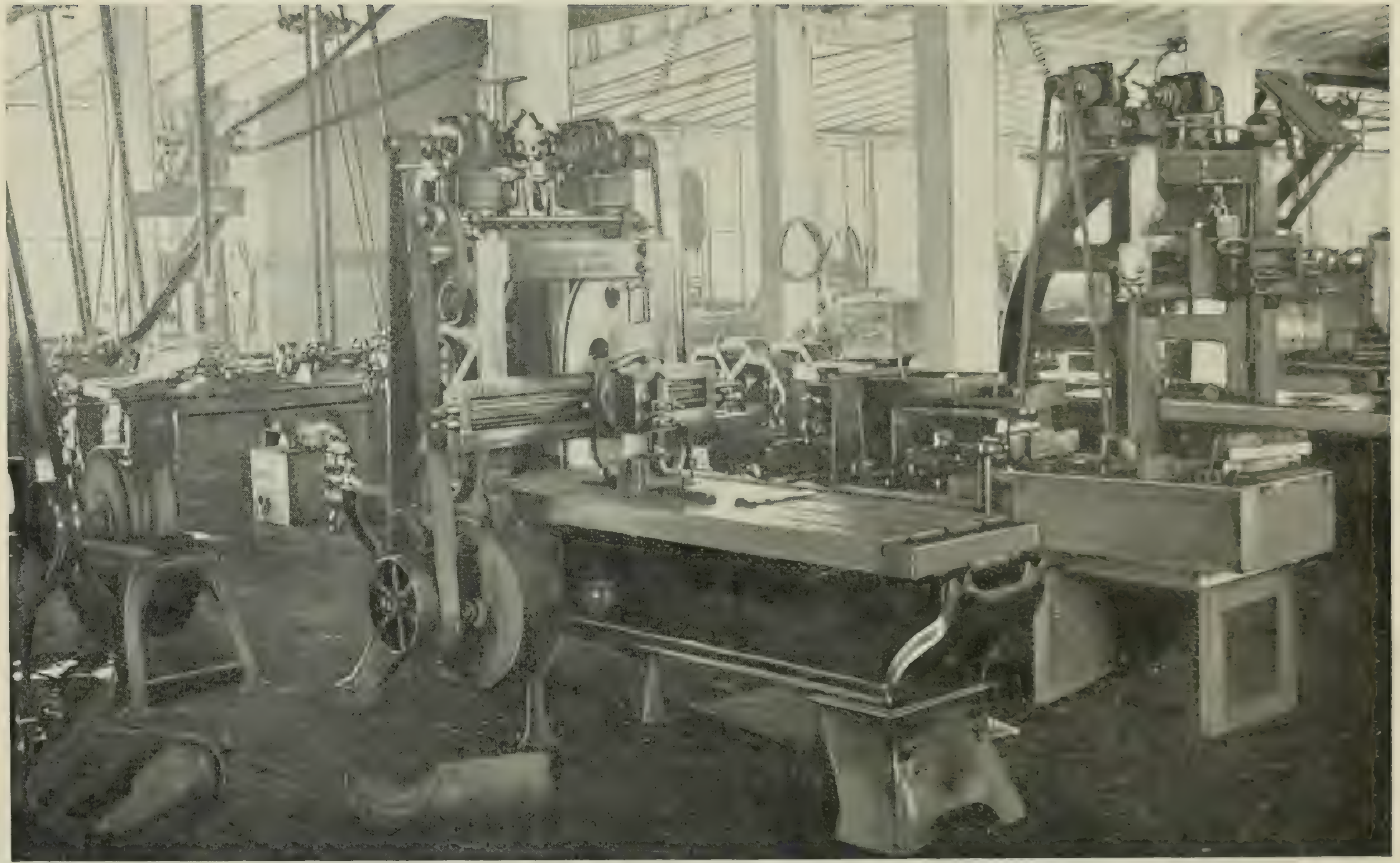
The most modern and elegant boats now running on the Hudson River are the New York and the Albany, two steam vessels which are the finest river passenger steamboats in the world. They are stanch craft, well arranged, and beautifully finished and furnished,—ideal American river steamers. Either is able to make twenty-four miles an hour. The general design is quite different from that of the old-time river steamer. There are no boilers on the guards, and many established rules that entered into the designing of the Hudson River steamboat of twenty years ago have been ignored in their construction. Yet they may be compared to the old class of steamboat as we compare our modern naval vessels to those of civil war times. There are those who can see little beauty in our new cruisers and battle-ships, but go into raptures over the appearance of one of Uncle Sam's old "wooden walls"; so there are steamboatmen and others who prefer the appearance of the Mary Powell to that of the Albany, or would rather gaze on the outlines of the Alida than on those of the elegant New York.

However the appearance of the boats has changed, the paddle-wheel and beam engine have held their own through all. A number of attempts have been made at times to introduce the propeller,—notably in the City of Kingston, on the Rondout line, and the Nupha, on the Catskill route,—but these boats soon gave way to side-wheelers.

On no other river in the world has such a succession of magnificent passenger boats been run as on the Hudson. Having their own distinctive type, and that the best adapted, in point of speed and comfort, for passenger travel, they have always held a high place in the maritime world.



"A PRINTING ESTABLISHMENT IN NEW YORK HAS RECENTLY PUT IN AN ELECTRIC PLANT FOR DRIVING ALL THE PRESSES AND OTHER MACHINERY." SEE PAGE 875.



"PLANERS DRIVEN EACH BY TWO MOTORS, ONE FOR THE FORWARD AND ONE FOR THE BACKWARD MOTION." SEE PAGE 875.

ELECTRIC POWER FOR ISOLATED FACTORIES.

By W. A. Anthony.

THE use of isolated lighting-plants in manufactories has been in vogue for several years both in country and city, and is now so common that hardly any manufactory of any pretensions is projected in which the lighting-plant does not form a part of the original plan. The great advantage in convenience and economy is so well recognized that it is unnecessary to dwell upon it. The advantages of using electricity for the transmission of power from the steam-engine or other prime mover to the work are, however, not so well understood, and this means of transmission is by no means so generally employed as its advantages warrant. That power can be transmitted by electricity is perfectly well understood; generators, motors, and conductors are at hand; what remains is to demonstrate the advantages over other modes of transmission,—to show that it will "*pay.*"

It is not claimed that electrical transmission is in all cases superior to other modes. Each case must be considered by itself, the various conditions studied, and the advantages and disadvantages of the different possible means of obtaining the power at the point where it is to be used carefully weighed. If the problem is to deliver the power of a waterfall at a distant point, the question to be answered is a very simple one: Will the power delivered cost less than if delivered by other means, or than power generated on the spot? These costs are not difficult to determine in any particular case, and the question can easily be answered. There are numerous examples of such transmission, but the advantages are not always so great as they seem. The original cost, and cost of maintenance, of a water-power plant not infrequently render it anything but an inexpensive source of power; and, when there is added to this the element of variability and uncertainty that often exists, it is not uncommon that the advantages are in favor of the steam-engine on the premises.

The distribution of power by electricity from central stations to numerous small consumers has especial advantages, and is in extensive use. When consumers are scattered, there is no other method of distribution by which they can be so easily reached, and no other method by which they can be supplied with so little loss. Exactly in the same line is the electrical distribution of power from a central point to the scattered shops of a large manufactory. At first this took the form of motors driving lines of shafting, or, if machines were scattered,

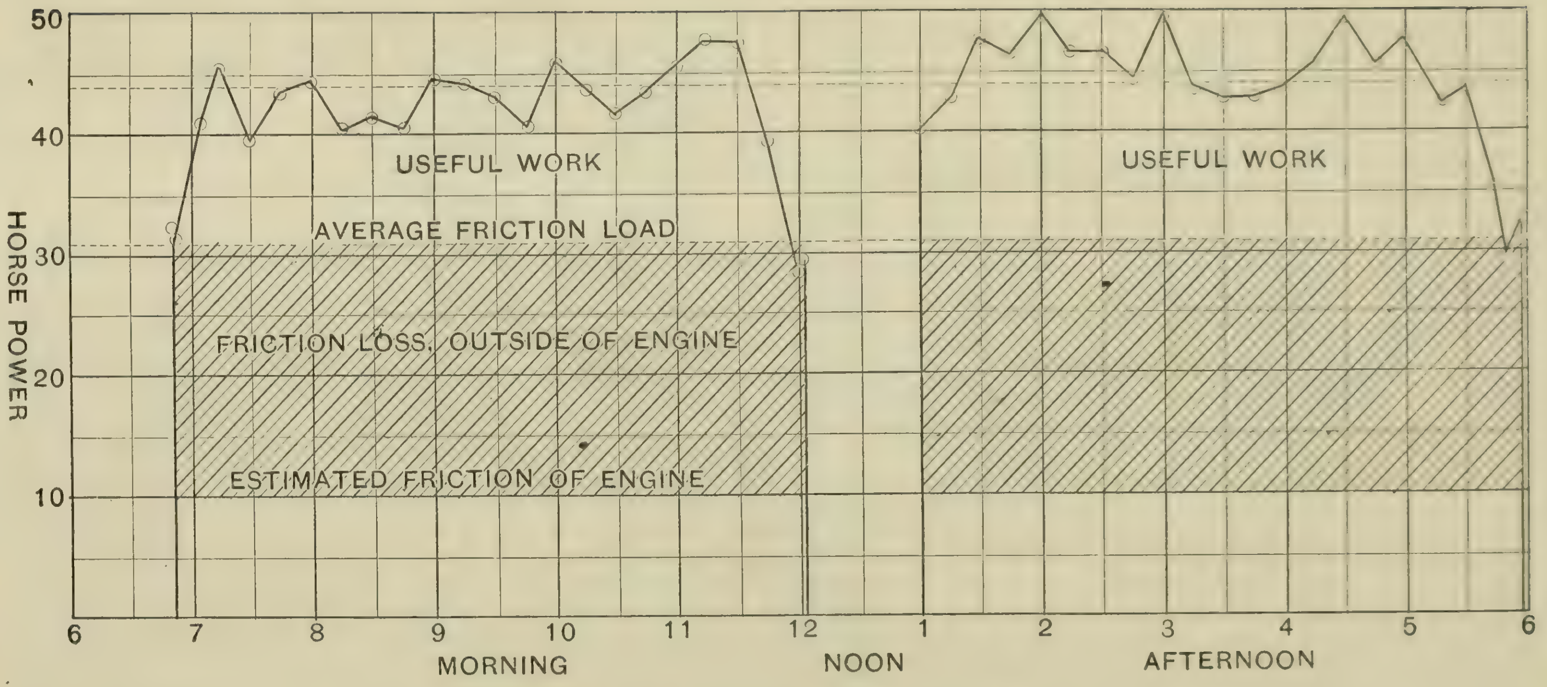


FIGURE I. "A TYPICAL LOAD DIAGRAM."

motors were in some cases used to drive individual machines, the advantage of the motor over a long line of shafting being apparent. But now the question arises: just how far can electrical distribution displace shafting? The answer can only be given for each special case, after studying all the conditions.

The following general considerations will assist in arriving at a solution:

The cost of shafting per unit of power transmitted is least when machinery is compactly grouped in close proximity to the source of power. In such case, furthermore, the proportion of power lost in this mode of transmission is least,—that is, the efficiency of transmission is highest.

The loss by friction of shafting and belting is constant whether the machinery it is intended to drive is in use or not; hence, when machines are not in constant use, the efficiency of transmission is lowered.

In an electric plant the cost of conductors is comparatively small, and widely-scattered machinery may be reached with only a small addition to the cost of the plant.

When individual motors are used for each machine, the motor stops with the machine, and with it the flow of current from the generator. Hence stopping a machine stops its proportion of the loss in transmission. It is the same as though the machine were driven from the engine-room by an independent line of shafting which stopped with the machine.

An electric motor consumes current nearly in proportion to the load; therefore, it may be used for light loads without excessive waste of power.

An incidental advantage in the use of individually-driven machines is the absence of conditions other than the requirements of the work, to control the location or alignment. A machine having its own motor mounted upon it may be placed where it is most convenient to the work it has to do, without regard to the position or direction of lines of shafting.

Another advantage is the absence of dust and dirt from running belts.

The waste power from the running of shafting and belting while some of the machines they are to drive are idle varies greatly, of course, in different plants. It will be least in manufactories of staple goods, where all parts of the plant are so proportioned and balanced that each machine must run continuously. It is greatest in repair and jobbing shops, and in manufactories doing custom work. In such plants a great variety of machines must be provided to meet the exigencies that may arise, and many of these machines find only occasional use.

The waste power may be determined in any given case by measuring the power consumed at short intervals through the day. This may be done by means of a dynamometer, by taking indicator diagrams from the engine, or by any other suitable means. If a shaft is driven by an electric motor, a recording ammeter will give the best possible indication of the character of the load. The Crocker-Wheeler Electric Co. has made measurements of several plants for this very purpose, and by their permission I reproduce here [Figure 1] a typical load diagram. The broken line represents the indicated power at the engine cylinder at intervals of fifteen minutes through the day. The average load for the day is 44.1 horse-power. Of this 12.8 is useful load, and 31.3 is friction of engine and shafting. Ten horse-power is assumed as the friction of the engine, leaving 21.3 horse-power for shafting,—about 62.5 per cent. of the power delivered by the engine, and 166.4 per cent. of the useful load. If this power were electrically transmitted, the power lost in transmission should not be more than half the useful load, or 6.4 horse-power,—a saving of 14.9 horse-power. This power would cost in such a plant not less than $60 per horse-power per year, or $894. Assuming that an electric plant to replace the shafting would cost $2000, interest and depreciation would amount to $200,—a saving of $694 per year by the electric plant.

Figure 2 is a load diagram from one section of a large silk manufactory where the conditions are especially favorable to high efficiency in transmission by lines of shafting. The useful load is heavy and uniform, the increase after four o'clock being due to the turning on of electric lamps. The regular working-load is about 435 horse-power. The power indicated at 12-05 and 6-05—about 185 horse-power—is the friction load of engine and shafting. The useful load is, therefore, 250 horse-power. Estimating the friction of the engine at 50 horse-power, that of the shafting is 135 horse-power, and the efficiency of transmission is 65 per cent. A 400 horse-power direct coupled engine and electric generator, furnishing power to motors of 1 to 5 horse-power, should give an efficiency of transmission of 70 per cent., —a higher efficiency than shafting gives in this most favorable case. At this efficiency 357 horse-power delivered to the electric generator would give the 250 horse-power useful load; that is, the loss in transmission would be 107 in place of 135 horse-power. This saving of 28 horse-power is worth, at $40 per horse-power per annum, $1120. It is a question whether, in this most unfavorable case for electric transmission, the saving effected would not more than pay for the electric installation.

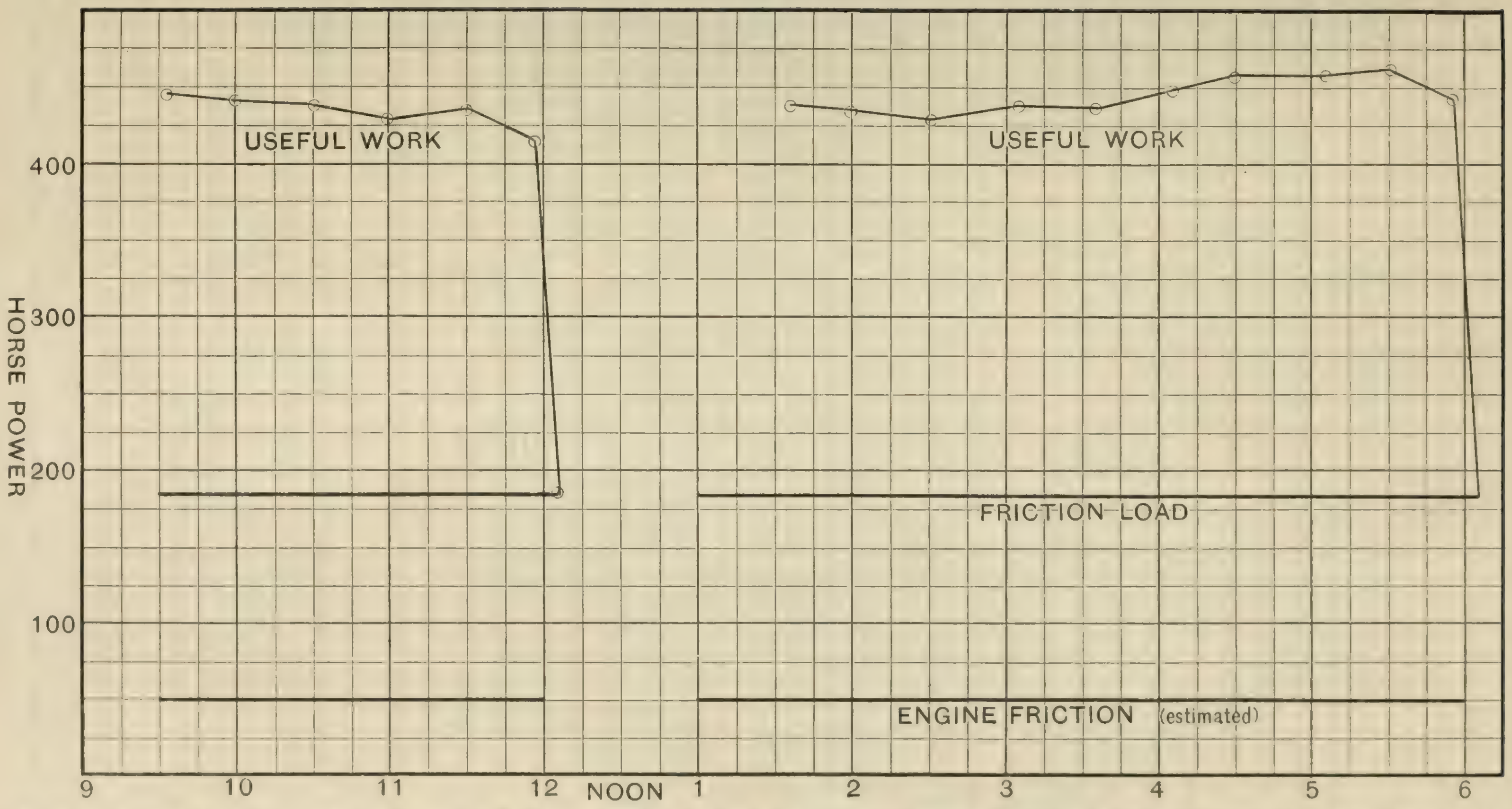


FIGURE 2. "A LOAD DIAGRAM FROM ONE SECTION OF A LARGE SILK MANUFACTORY WHERE THE CONDITIONS ARE ESPECIALLY FAVORABLE TO HIGH EFFICIENCY IN TRANSMISSION BY LINES OF SHAFTING."

It has been already stated that the first applications of the electric motor in manufactories was to drive machinery through lines of shafting. This was an obvious application, furnishing an easy means of reaching machinery in out-of-the-way places, or scattered buildings. The efficiency of transmission was not so much considered as convenience in reaching the machines to be driven. But it is evident that, in using shafting driven by electric motors, the losses of both systems of transmission are added, and it would seem that, if the full benefit of electric transmission is to be obtained, shafting must be entirely done away with, and a motor used to drive each machine.

This would be true, if large and small motors were all of the same efficiency; but, because of the higher efficiency of large motors, it may be of advantage in certain cases to group a number of small machines about one motor, using short lines of shafting for transmission from the motor to the machines.

A brief description of some typical plants will bring out more clearly the advantages of electrical transmission.

A large brewery in Milwaukee, whose buildings cover several blocks, has an electric power-generating plant at a central location, and the power is distributed electrically to the various buildings. The generating plant consists of a compound condensing engine driving two 120 kw. power generators, and a 60 kw. generator for lights. The motors are 50, 40, 30 horse-power, and smaller, twenty-three in all. In one case two 50 horse-power motors run in multiple upon the same shaft. In this plant the conditions were such that no other provision for power was possible, except the location of separate steam plants at the points where power was needed. The advantage in this case was the location at one point under one engineer of a generating plant of the first class, in place of small engines of lower efficiency at scattered locations, requiring several engineers. There was a saving of wages of engineers and firemen, a higher economy in the use of fuel, and the further advantage that the power at any point was always ready when wanted.

In a large plant at Greenpoint, Long Island, for building iron bridges, roofs, etc., electric transmission is used throughout. The machines consist of heavy punches, shears, bending machines, etc., which are used as the work in progress demands. In general, each machine is driven by an electric motor. In a few cases two or three machines are driven by one motor through a short line of shafting. One important incidental advantage of the use of electrical transmission in this case was apparent at first sight of the plant. The location of machines was made to suit the work. There was no shafting to control the alignment, and no belts were to be provided for. The nature of the work to be done is such that the use of the tools must to a great extent be intermittent. Indeed, there were installed altogether 149 horse-power in motors, while the generator that furnishes the current, not only for the motors, but for the arc and incandescent lamps for the entire establishment, is only 75 horse-power. The tools in this plant cover a large area, and, although they are under one roof, shafting to reach them all would consume continuously more power than is consumed by all the tools usually running at any one time.

A printing establishment in New York has recently put in an electric plant for driving all the presses and other machinery. The illustration on page 867 gives a view of one side of the press room, showing a line of presses, each driven by a Crocker-Wheeler motor, geared directly to the driving shaft of the press. Another line of presses occupies the opposite side of the room, and other machinery driven by individual motors occupies other floors in the building. There is an entire absence of belting and shafting. Each press is handled entirely by its motor through the motor-starting box, which is placed where it is most convenient to the hand of the operator. Whenever a press stops, the transmission loss stops with it, and, as the machines of a printing establishment often have long periods of rest, the economy of electrical transmission is apparent. A 15 kw. generator supplies current not only for the motors, but for all the lights of the establishment.

Several of the methods of employing electric transmission are exemplified at the Crocker-Wheeler factories. Power is carried to scattered buildings, to short lines of shafting in the same room, to individual machines by belting to the machine from a motor suitably placed and by making the motor an integral part of the machine, to hoists and cranes, etc. The illustration on page 868 shows planers driven each by two motors, one for the forward and one for the backward motion.

In the use of motors for running drills, lathes, and other machines requiring to be run at different speeds, it is important to avoid changing the speed by means of resistances in the armature circuit, as the efficiency of the motor is then very low, and the high efficiency, which is one great advantage of electric transmission, is lost. Change of speed should be obtained by some mechanical device, or by such a construction of the motor as will permit variation of the speed by varying its counter electro-motive force.

It must be borne in mind also that one great advantage of electric over shafting transmission results from the stopping of the motor when the machine is idle. To secure this advantage the motor should be geared to the machine in such a way that the motor must be stopped to stop the machine. If the connection is made by means of a clutch, or fast and loose pulley, which the operator ordinarily uses for stops of short duration, it will be found that the motor will be allowed to run, and much of the possible advantage lost. Even where load is most uniform and machines in most constant use, the idle time will not be less than five to ten per cent., and if motors are stopped during that time, it will effect a saving of that percentage in the transmission load.

Many machines, especially machine tools, hoists, blowers, etc., have been built in which the electric motor forms part of the original design, and this construction will find wider and wider applications as the advantages of electrical transmission come to be better understood. In many cases, as in the printing presses illustrated in the cut, no essential change of design is needed to enable the motor to be geared directly to the machine.

The electrical-transmission plants described or referred to in this article have been given only as typical examples. Many other examples might have been adduced, in some cases comprising a thousand horse-power or more in a single plant. Almost every variety of manufactory may advantageously employ electric transmission. The Crocker-Wheeler Co. are arranging to attach motors to silk looms for a silk manufactory now in process of erection. One advantage to be gained in this case is cleanliness.

As already stated, the advantages of electric transmission will vary greatly under different conditions. The cost of an electric installation will, perhaps, in most cases exceed that of shafting and pulleys, but in so many cases does the saving of power more than warrant the additional outlay that it would be a mistake in any new project not to have made a careful estimate of the relative advantages of electric compared with other modes of transmission. It is not to be expected that the advantages to be derived will in many cases warrant the discarding of machinery and lines of shafting forming the equipment of established manufactories ; but, in the case of new projects, where everything may be planned from the beginning with reference to electric transmission, every advantage of this method may be secured. Machines can be located to suit the work ; where necessary, the entire space overhead may be kept clear of all obstructions, even of wires ; the lighting of the establishment can be provided for off the same system ; machines in out-of-the-way places may be supplied with power,—in short, the system offers many advantages besides higher efficiency, and no disadvantage except a greater first cost.

THE CONSTRUCTION OF A GREAT BUILDING.

By Francis H. Kimball.

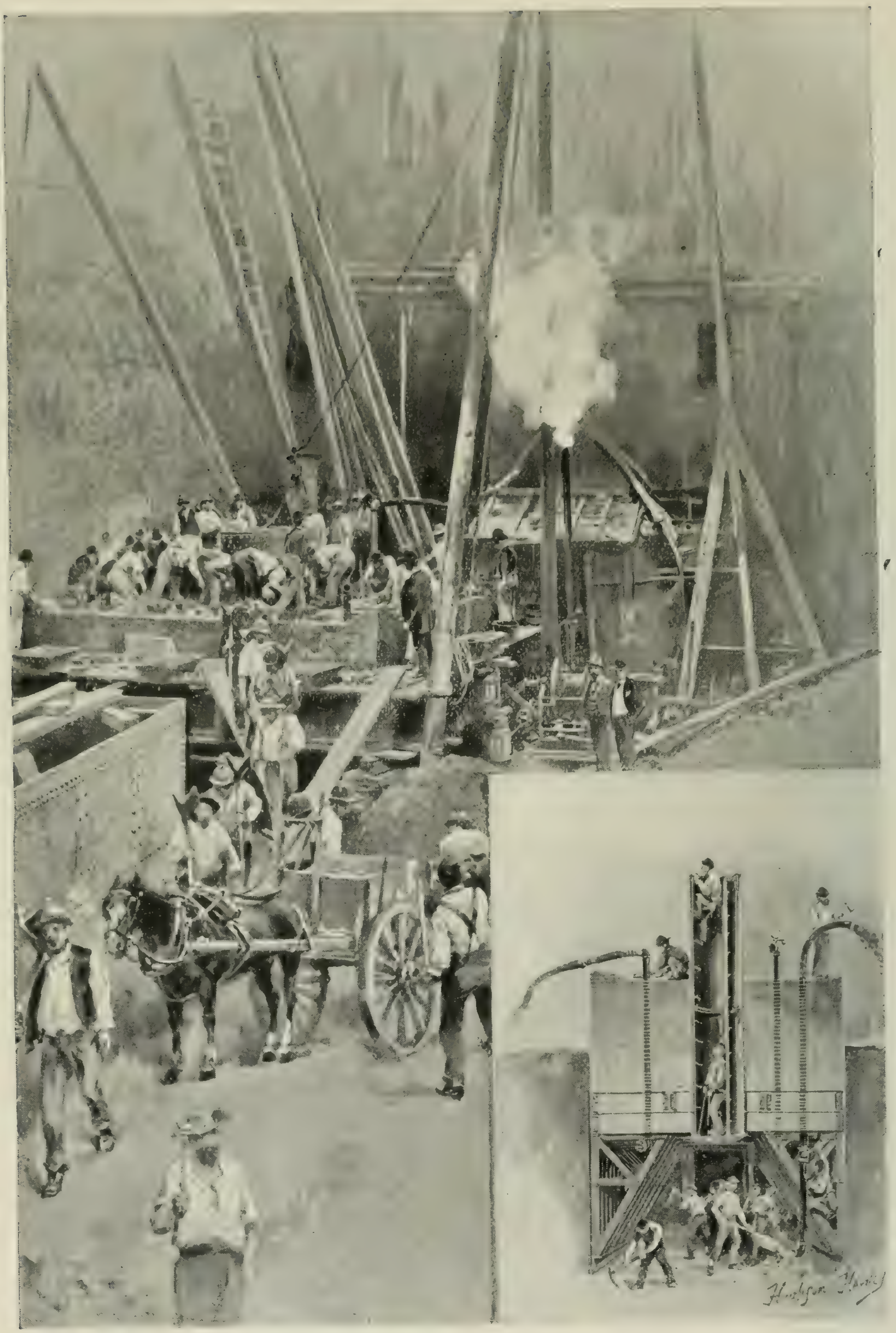
IT is but a few years since it was considered among the wonderful accomplishments of the time to erect and equip an office-building of ten stories in height in a period of twelve months, starting on the first day of May to remove the existing building, and in the following May turning over to the owner the finished production. Something more is expected of the architect and builder of the present day. In place of ten stories, twenty are now considered only a fair year's work, providing the conditions and season are favorable.

Is it because we are any better equipped in appliances or machinery that we can double the production of former days, and are our mechanics more skilled in the use of tools and quicker in their movements? Or is it due to a gradual development, year by year, of improved methods in handling men and material?

Examples of quick building of the present time point undoubtedly to a great extent to the latter theory, although new methods of construction have been introduced within the last ten years tending to greater facility in the erection of the structural parts. We have the same master and the same mechanic with us to-day, who, without any more apparent exertion, will put up a twenty-story building in the same time it took them ten years ago to put up ten stories. At the same rate of progress, we shall expect them ten years hence to put up a thirty-story building in the same time.

All of this depends largely of course on the difficulties encountered, among the greatest of which is that of securing a proper foundation for such a gigantic structure. Another—and one which builders fear most—is labor troubles, from which none of the large buildings thus far erected has been free, and to which much of the delay is due. But, given a fair start, by which is meant ample preparation for the architect in working up his plans, and good builders in accord with the architect in all his views, there seems to be no apparent reason why the limit of a year's work need be twenty stories.

The stability of such a structure, the materials entering into which are piled up and put together so rapidly, is a matter of serious consideration. We may be leaving to our successors a troublesome inheritance; not that we are working close to the danger limit in our calculations of strength, but that we are trying to force out of much of the material used more than its character seems to warrant, the

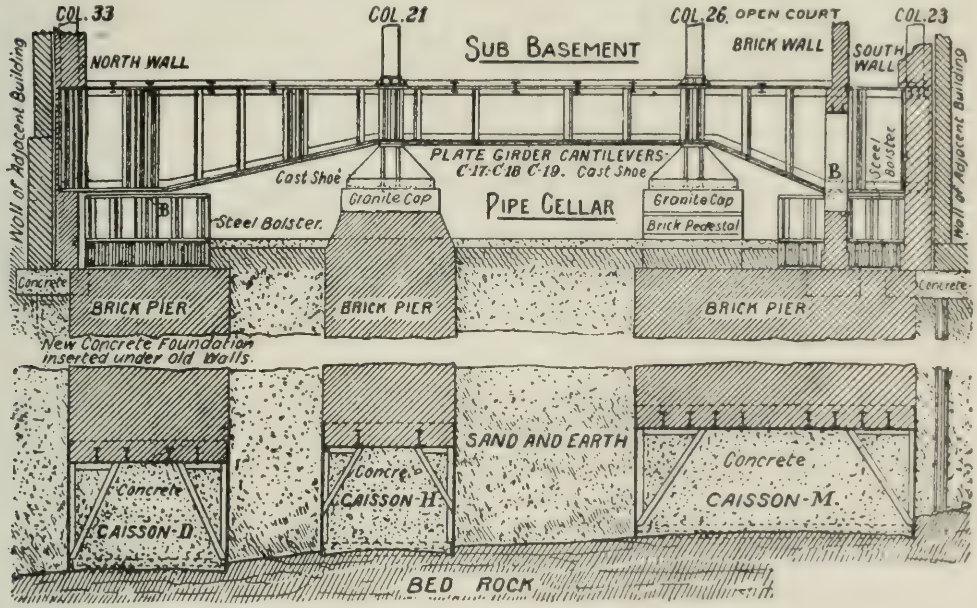


PREPARING THE FOUNDATION.

consequence of which will be constant repairs in the future, involving in the aggregate a cost exceeding the saving realized in the quicker returns on the investment at the beginning.

But architects know all this, and so does the investor in a great measure; yet the temptation to excel some other record in the quick-building line, together with a desire for quick returns from rentals, losing but one season, is more than the investor can withstand. The architect has no choice in the matter; he must accept the inevitable, and bring to bear all his skill to accomplish the end desired in the best and most workmanlike manner.

It is not difficult, at the close of one of these quick-building operations, to trace the reasons which led to so successful a termination

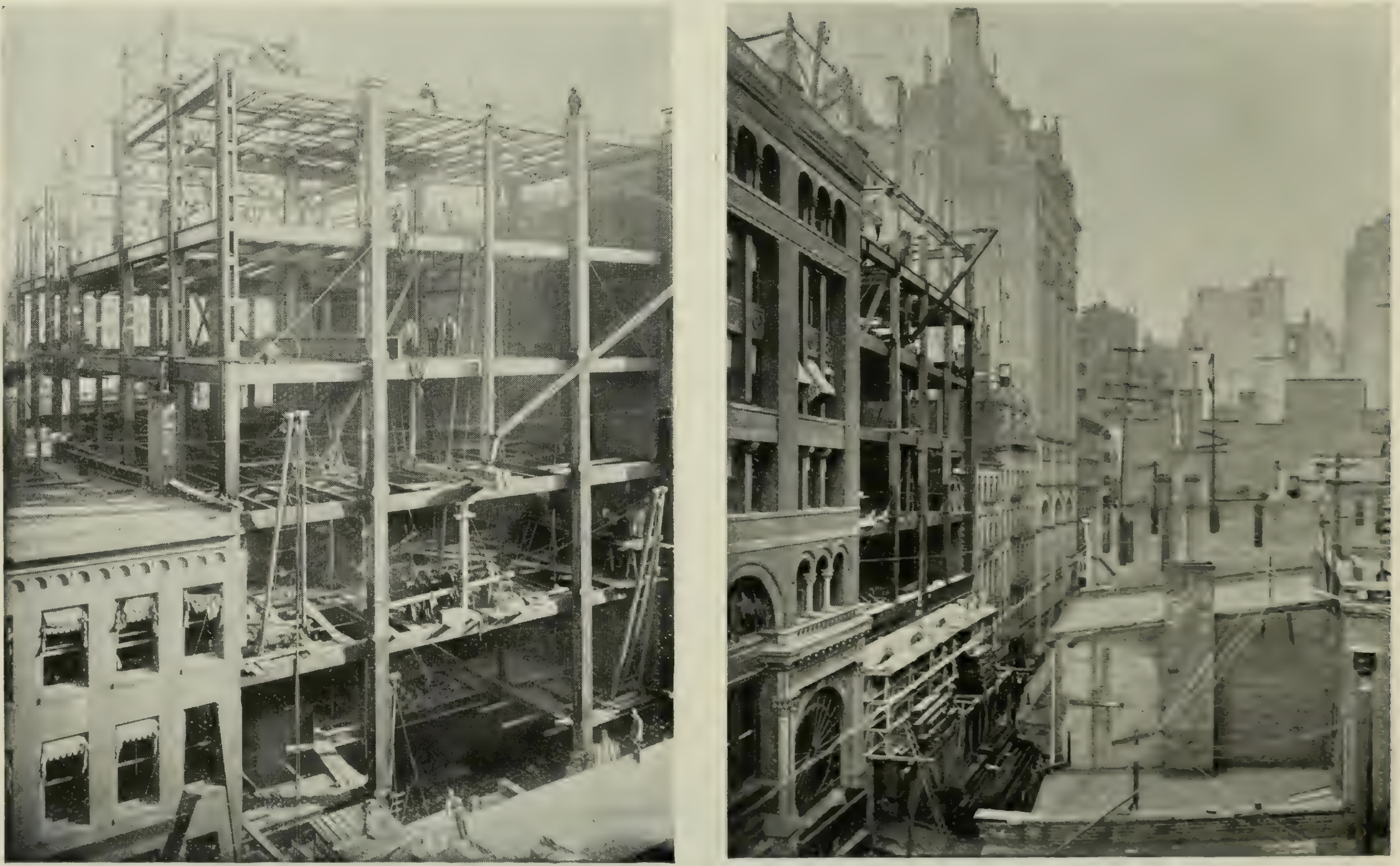


PLAN SHOWING FOUNDATION OF BUILDING.

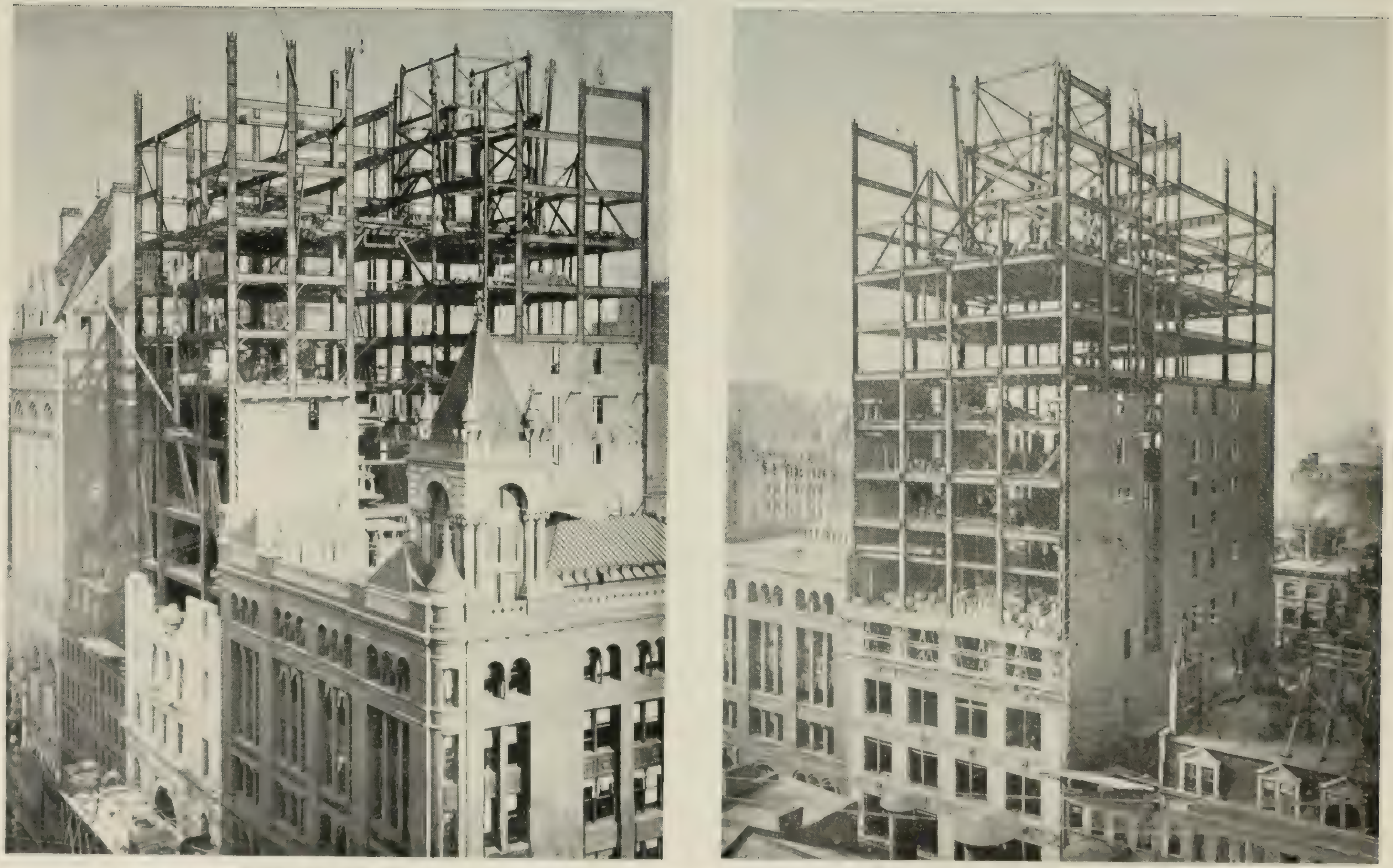
The most recent example, in point of the actual time consumed in erection and in finishing the great bulk of the building,—which has not been equalled up to the present time, pound for pound of iron and brick for brick of masonry,—is the Manhattan Life Insurance Building, with which the writer is identified.

No comparison can be made between New York and Chicago records, as our building laws are much more rigid, in that they exact a greater degree of stability in the structural features.

In the case of the Manhattan Life Building, the time consumed in its erection may be divided into two parts, as follows: foundations ready for super-structure, five and two-thirds months; super-structure, eight months. The roof, or eighteenth tier of beams, was reached in exactly three months from the time when the foundations were ready,



BROADWAY—OCTOBER 17TH, FIRST SIX STORIES OF THE STEEL FRAME COMPLETED—NEW STREET.



BROADWAY—NOVEMBER 18TH, STEEL FRAME COMPLETED TO 14TH AND STONE WORK TO 5TH STORY—NEW STREET.

on which to set the first piece of steel composing the bolsters that support the cantilever system.

The time spent in preparing the foundations may seem, to those unfamiliar with this work, scarcely consistent with the progress afterward made, but the architects found that, in view of the unsatisfactory nature of the ground, composed largely of quicksand, the usual methods employed, such as piling or masonry, were inadequate for the purpose of a foundation to sustain the great concentrated loads; and they thereupon decided to reach bed-rock, fifty-seven feet below Broadway, by some unprecedented means. They finally concluded to introduce the pneumatic process used in sinking bridge piers to rock, an illustration of which process, as used under the Manhattan Life Building, is herewith given.

Sinking the piers to bed-rock rendered the building independent of any outside operations,—either building foundations or tunnels. The fact that they were the pioneers in this undertaking, so far as the application of this principle to building work is concerned, led to much carefulness on the part of the engineers, Messrs. Sooysmith & Co., in respect to the probable effect on the foundations of adjacent buildings; and that there might be no disturbance of such foundations, by reason of going so far below them, no attempt was made to force this work to the degree attained in bridge work where operations are carried on in an open country.

The magnitude of the work may be better understood by reducing it to cubic yards of masonry. This sub-structure, which starts on bed-rock and continues up to the level of the cellar floor, consists of fifteen piers, varying in size from 9′ 0″ in diameter to 21′ 6″ × 25′ 0″ square. The caissons made of steel corresponded in size to the piers they sustain, and were eleven feet in height. These caissons were filled with concrete, and contained altogether 1260 cubic yards. The number of bricks used in the piers amounted to 1,500,000.

From this it may be seen that a good sized building was sunk out of sight before any part of the super-structure could be begun.

The fact that a new method, with more or less experimental work attending its adoption, had to be devised, and the really large mass of masonry forming the piers, are sufficient excuses for the length of time consumed in this feature of the building. It was a work which in olden times might have taken twelve months. Even the progress attained was due to the fact that three relays, or gangs of men, were employed in sinking the caissons, thus giving the work the benefit of the full twenty-four hours in one day, for the entire period of five and two-thirds months, except in the case of the masons, who worked only during regular hours.

The super-structure, when once started, proceeded rapidly, the rates of progress from month to month being shown by the views herewith given. What is not apparent in the views is the complicated nature of the construction, due to the form of the open court, the special framing to meet the arrangements of the Company's quarters on the sixth floor, the great height and weight of the tower, and provision for wind-bracing, in consequence of which all the stories could not be erected with the same degree of rapidity.

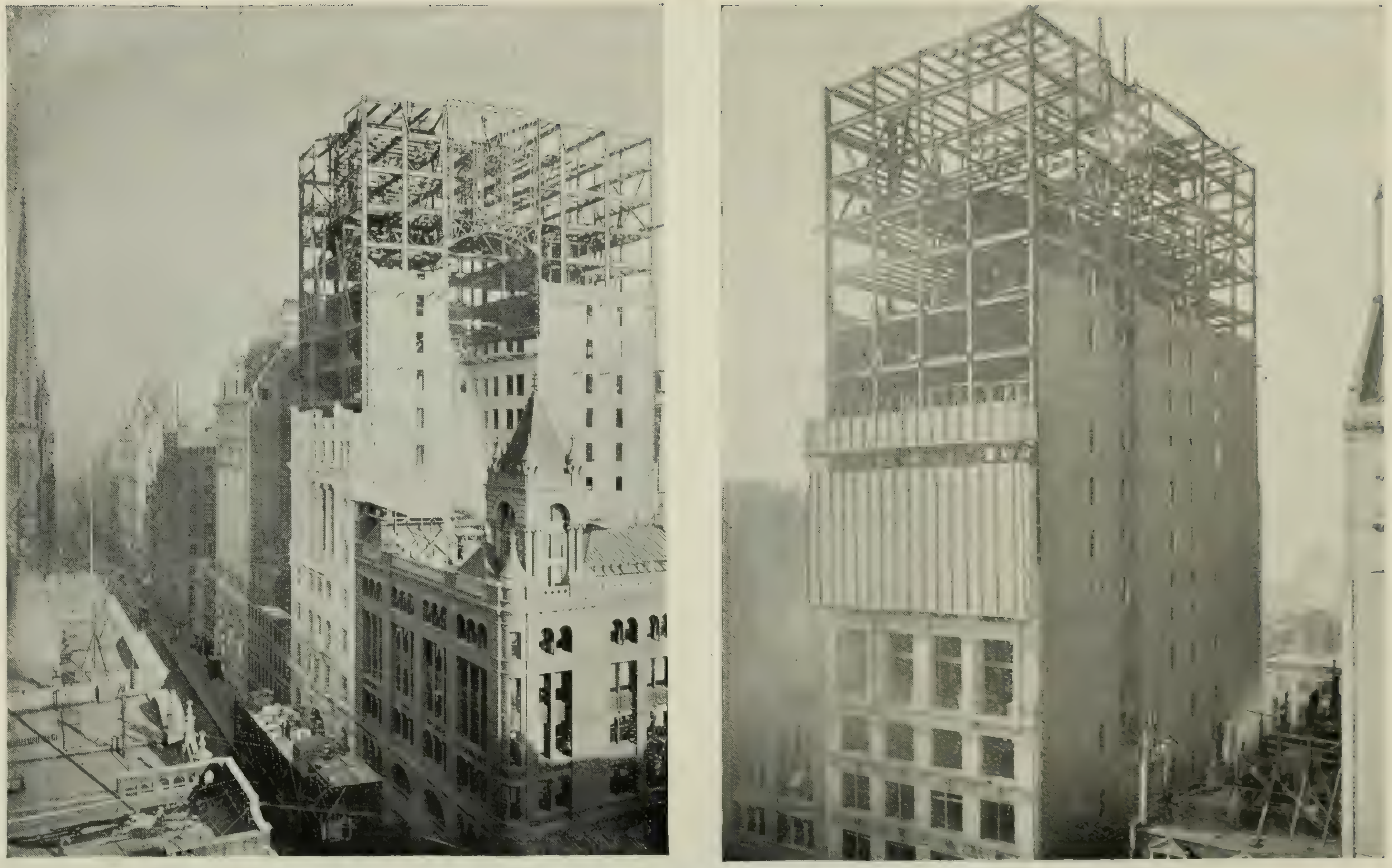
Suffice it to say that in three months about 5800 tons of steel were raised into position. This was not accomplished, however, without night work. When the foundation work was prolonged to September 1, the prospect of completing the building on May 1 was not promising. A council was held,—attended by the building committee, architects, and builders,—the purpose of which was to incite the builders to greater activity, and also to settle upon a plan for beginning and continuing night work until the roof was reached.

This meeting resulted in the institution of day and night gangs of men for the erection of the steel frame; and by reason of the time which, in consequence of the delay in the foundations, the contractors for this branch of the work obtained for the making of the wrought material and the delivering of the same within a short haul of the building, coupled with the fact that great care was taken at the rolling mills in laying out the various members to templates so that, when they were assembled at the building, no fitting was required, the work of erection went on without interruption from the beginning to the end. Recalling the incidents of these three months' work, and the system employed to produce the quickest results, it seems that no mistakes were made and that every moment was counted.

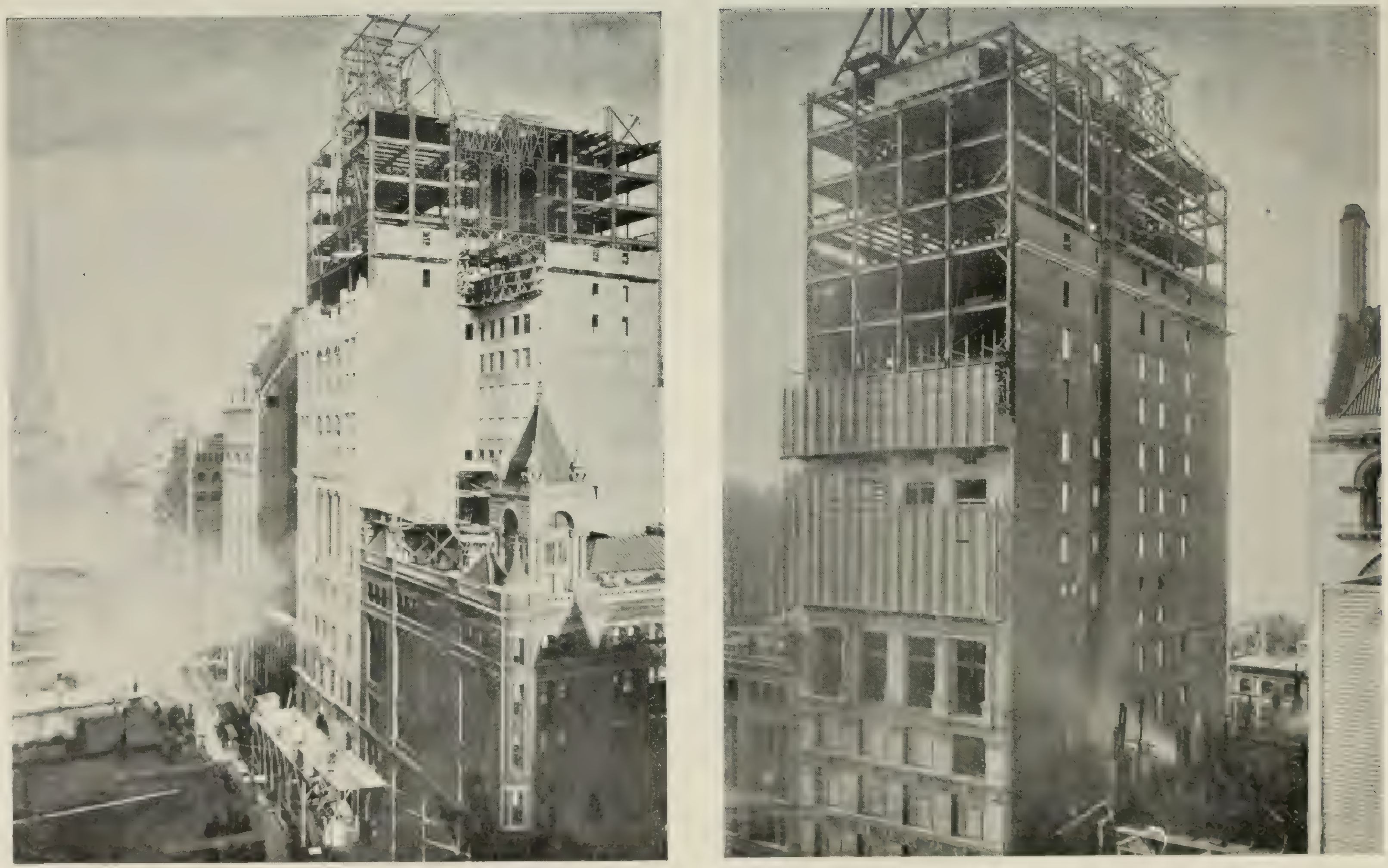
To better illustrate the magnitude of the skeleton, I may say that there were girders weighing forty tons, many columns of ten and twelve tons each, and cantilevers of eighty tons (in four sections of twenty tons each), the length being sixty-seven feet.

All of these heavy members required special means of transportation; the heaviest girder had to be rolled from the dock to the building by night, the task requiring three nights. It took just twenty minutes to raise it from the street to its position on the second floor.

On account of the great risks where material must be raised three hundred feet in the air, and the haste with which the work must be done, the setters of iron and stone work should be picked men with certain qualities, the most prominent of which must be good judgment and steady nerves. It is rarely that serious accidents and even deaths are not recorded against buildings of even less magnitude than the Manhattan Life Building, but, strange to say, in this case there was



BROADWAY—DECEMBER 8TH, STEEL FRAME COMPLETED AND STONE WORK UP TO THE 9TH STORY—NEW STREET.



BROADWAY—DECEMBER 27TH, STEEL TOWER BEGUN AND STONE WORK UP TO THE 13TH STORY—NEW STREET.

no loss of life, and but few accidents worth mentioning. The work was greatly facilitated by the use of a traveling frame, with a derrick at each angle, by which material could be easily disposed of as it was raised from the street, and placed in its proper position.

It was considered advisable to begin the brick masonry when four stories of the steel frame had been set in position. This enabled the frame-setters to keep in advance of the other trades. As far as possible, this plan was pursued throughout ; but, inasmuch as bad weather has no effect on iron and steel, while with masonry the contrary is the case, at times it was necessary to lay off the masons while the others pursued their work. When high winds prevailed, all work had to cease. But with good weather, when all could work advantageously, the masons could hardly hold their own.

There seemed to be a friendly rivalry between the two trades as to which should outstrip the other ; and the greater the exertion the brighter was the prospect of closing in the building before cold weather set in.

Rough piping, both for plumbing and steam, began when the masons had reached the fourth story, and continued without interruption until all the lines, vertical and horizontal, with all their branches, were in position. In the meantime the masons had begun setting the fire-proof blocks forming the partitions, and as far as practicable this was carried along with the advancement of the outside walls.

When the partitions of a story had been set, the electrician ran his wires, enclosed in conduits, to the various fixture outlets. One can hardly realize now that this "roughing," as it is called by the workmen, is concealed from view,—that more than five and one-half miles of gas, water, waste, and vent pipes, five miles of steam pipes, and thirty-five miles of electric wires, were required to perfect the respective systems. The facing of the front on Broadway contains about thirty thousand cubic feet of stone, which was cut and set in position in eighty days.

It was not at first the idea to undertake to finish more than ten stories by the first day of May, as the plastering could not be commenced until the winter was well advanced, and the outlook for enclosing the roof seemed distant and discouraging. When the twelfth story was reached, a temporary roof was deemed necessary for the protection from rain and snow of all the stories below ; and such roof was constructed, and was of great help in removing all fear of damage to the finer grades of interior fittings.

Immediately thereafter plastering was begun, temporary heat was supplied, windows enclosed, and a general advancement made towards the completion of the stories below. There was no cessation, however, in building above this temporary roof. Fortunately the weather was propitious, causing but little delay. The building was permanently enclosed by the time severe weather set in. Then all the forces that could be brought to bear were employed in the supreme effort of getting the entire building in such condition that tenants could occupy on the first of May any rooms that they might choose. It was successful. It proved a good investment for the company, as the greater proportion of the offices rented were above the sixth story.

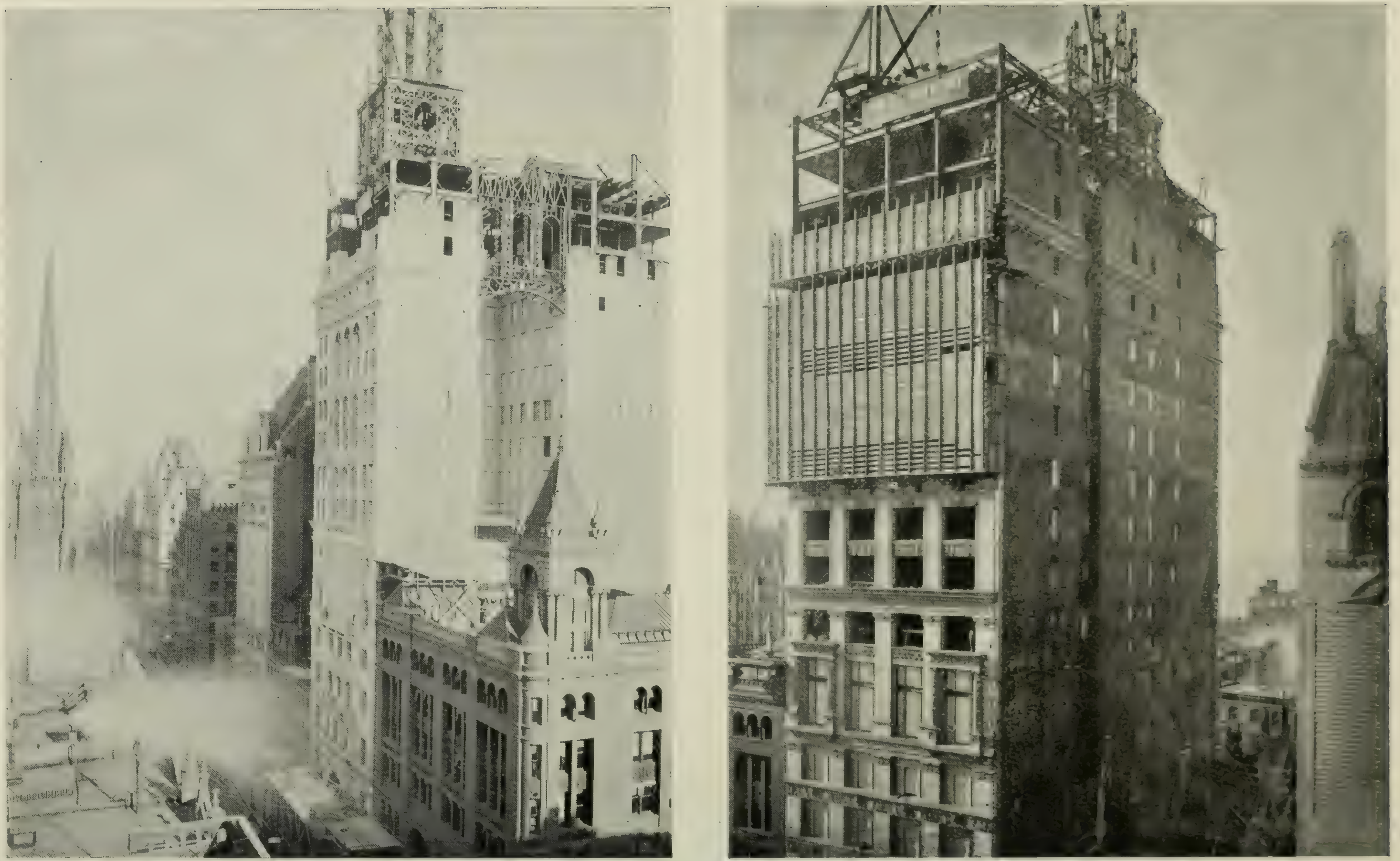
To follow all the different trades, and describe the various methods employed to force the work almost beyond the limit of human endurance, would be an interesting story. Suffice it to say that to the layman there can be no realization of the vastness of the undertaking.

Take the laying-out of the engineer's department,—the boiler and engine, the electric and elevator plants, the plumbing and heating systems contained in a building of this magnitude, the decorative treatment of the interior, employing the carpenter and cabinet-maker, plasterer, marble-worker, and metal-worker (on stairs and elevator fronts), the mosaic and tile flooring, gas and electric fixtures for lighting, to say nothing of a more or less ornamental exterior,—and it seems hardly less than a miracle that all these different interests, all large because the building is large, could have worked harmoniously together, and achieved such satisfactory results in the period of eight months.

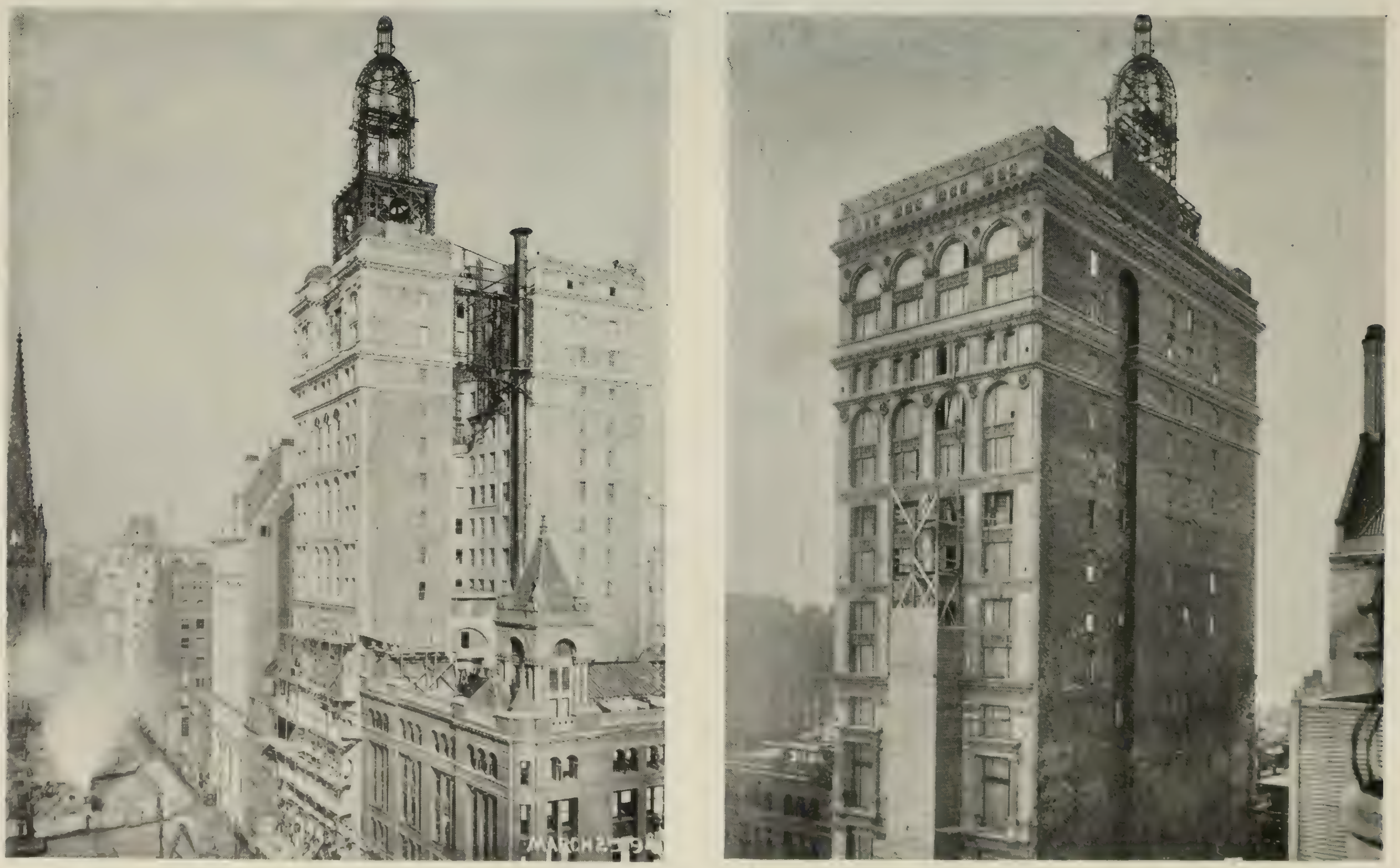
It might be asked: have manufacturers of building material kept up with the rapid advance in methods of handling, producing articles that will set more quickly, and reducing to the minimum the danger of destruction, such as that from dampness proceeding from brick, plastering, and concreting?

If the "drying-out" of a building could be reduced to a few weeks, instead of months, the length of time required for its erection would not be so much a matter of uncertainty. Some thought has been given to the mixing and manufacture of plaster, the application of which is made more simple than formerly by certain quick-setting qualities which make it practicable to put on the wood trimming within a few days after a room is white-coated.

There is yet room for improvement in the direction of freeing the process of plastering from dampness, and rendering it less objectionable, from the standpoint of cleanliness, to those who must follow the plasterers. But there is one feature of the mason's work to which much attention has been paid during the past ten years, but seemingly not in the right direction; for the difficulty remains, although the material is harder. I refer to fireproof blocking used for partitions and flat arches between beams. The blocks designed for partitions are not of uniform size; therefore the surface of one side of the partition



BROADWAY—JANUARY 12TH, FIFTH STORY OF TOWER COMPLETED AND STONE WORK UP TO THE 16TH STORY—NEW STREET.



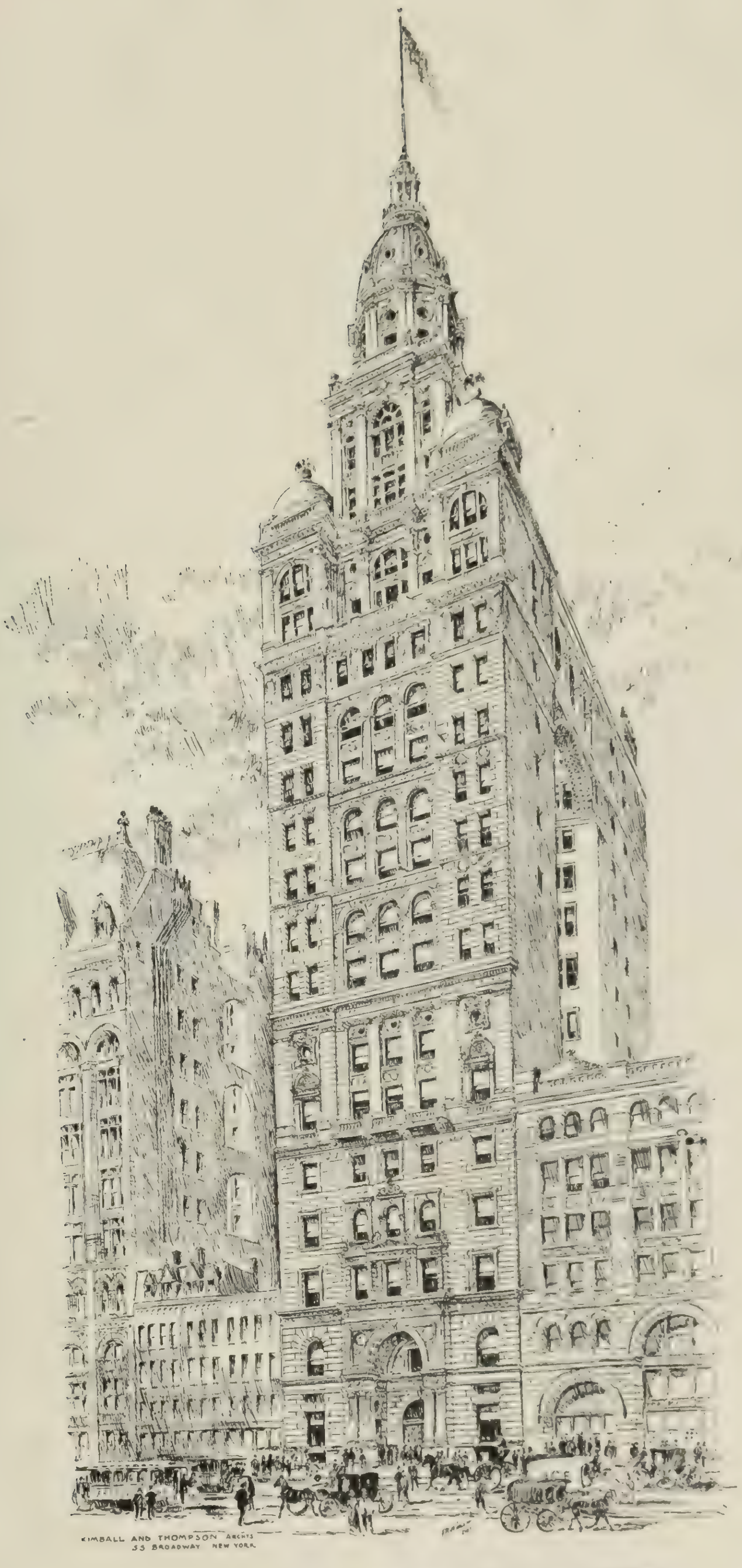
BROADWAY—MARCH 2D, STONE WORK COMPLETED, BUILDING ROOFED, AND TOWER READY FOR ENCLOSURE—NEW STREET.

becomes very irregular, as the mason lays up one side to a line. The plasterer must even up with plaster, the thickness of which varies anywhere from half an inch to one and one-half inches. It cannot be expected that the shrinkage of plaster will be uniform,—to say nothing of the danger of freezing when the work is done in the winter months. Fireproofing of floors between beams consists usually of flat arches formed of terra-cotta blocks made hollow to secure lightness. These blocks do not make up a thickness equal to the depth of the beam, where the beam is more than 8 inches. They vary in depth according to the span between beams; and, where the beam is more than 8 inches, there is a space above the arch to be filled, in order to meet the material of which the finished floor is composed. This space may be 4 inches, possibly 6 inches,—sometimes more, sometimes less, according to the depth of beam. The concrete is generally composed of ashes and cement, especially when saving in weight is important.

Such a foundation is not of the substance required where there is a direct action thereon,—as in the case of tile or mosaic floors,—proceeding from the heavy and constant traffic usual in business buildings. Consequently such floors show the natural impact of the spongy concrete by numerous cracks, which, in the case of mosaic floors, can never be properly repaired.

This defect is not the only one of importance. A large percentage of the dampness usual in mason-work proceeds from this source. As this concreting is usually done just before the laying of the floors, it is quickly covered in, and dampness must pass through the wood-flooring in the process of drying-out. It is natural to suppose that kiln-dried lumber will absorb much of the dampness, and swell in consequence, so that afterward, when heat is turned on, it will shrink and open at every joint. More thought should be paid to a remedy for this, which may properly be termed a defect. Arches could be made that would reduce the space referred to, thus removing an element which, although it may not materially retard quick building, causes much of the criticism on the defective work (so considered) now credited to rapid methods of building. Other features no doubt enter into this class of building to which attention might be directed with profit to the builder, but it is hardly possible to discuss them in detail here. The individual experiences of others would be interesting and valuable.

Without coöperation on the part of the builder, the architect's suggestions are of no advantage, and the work lags in consequence. It is important, therefore, that none but the most reliable men should be selected to do the work. The architect, moreover, should make the selection, for, if he is to come in for his share of censure in case of delay, it is better that he and his own men should wholly deserve it,



THE MANHATTAN LIFE INSURANCE BUILDING.

than that he should suffer for mistakes over which he has had no control. Should the whole work pass into the control of one firm (usually masons), it should be an arrangement satisfactory to the architects.

The architects of the Manhattan Life Building, Messrs. Kimball & Thompson, were ably assisted throughout, and they take great pleasure in publicly acknowledging their indebtedness to the different firms who aided them to make so remarkable a record. Messrs. Sooysmith & Co., engineers, did all the work in connection with the foundations and caissons. A. & P. Roberts & Co., the Pencoyd Iron Works of Philadelphia, finished and erected all the iron and steel construction, as well as the ornamental interior iron and exterior copper work. They sublet to Richey, Browne & Donald of Brooklyn all the stairs and elevator fronts, and other ornamental iron work, and to James White, also of Brooklyn, the copper work. All other contracts were assumed by Richard Deeves & Son, who sub-let the carpenter and cabinet-work to the Geo. C. Flint Co.; the marble, mosaic, and tile work to Traitel Bros. & Co., who in turn sub-let the marble portion to H. C. & G. S. Bailie; steam-heating to Gillis & Geoghegan; elevators to Otis Bros. & Co.; plumbing to J. N. Knight & Son; plastering to J. J. Roberts, for whom H. Berger's Sons did the ornamental plaster decorations; electric work to the N. Y. Electric Equipment Co.; boilers (of which there are three of the marine type, 10 feet in diameter) to the Quintard Iron Works, N. F. Palmer & Co. The elaborate bronze screens on the sixth floor, the Company's offices, were made by Richey, Browne & Donald; the color decorations and stained glass, by Arnold & Locke of Brooklyn; and the brass work around the engines and dynamos, by H. W. Steinert. All of these men took a personal interest in devising means to further the work, providing a sufficiency of men and materials at the proper times.

In the preparation of the drawings for the constructional steel and iron work, the architects called to their aid the services of Mr. C. O. Brown, engineer, who made all the extensive calculations and prepared the necessary drawings issued to the Pencoyd Iron Works.

Without an active building committee it is possible for an architect to fail, even though well-equipped in other respects. Prompt consideration of important matters arising from time to time is of valuable assistance to the architect. Such a committee the architects of the Manhattan Life Building were fortunate in having.

Finally: the secret of success always lies in constant, unremitting push in every department. Begin at the very beginning; an ounce of push at the start is worth a pound of push at the end. Start the trades whenever and wherever it is possible so to do, and keep up the tension; then satisfactory results cannot fail to follow.

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A An	American Analyst. *f.* $1. New York.
A & B	Architecture and Building. *w.* $6. N. Y.
A B D	Arch. Build. and Dec. *m.* $2. Minneapolis.
A CJ	Am. Chem. Journal. *b-m.* $4. Baltimore.
A E C U	Asso. of Eng. of Cornell Univ. 1894. Ithaca.
A E R J	Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G	Am. Geologist. *m.* $3.50. Minneapolis.
A G L J	Am. Gas Light Journal. *w.* $3. New York.
A J R A	Jour. R'y. Appliances. *m.* $2. New York.
A J S	Am. Jour. of Science. *m.* $6. New Haven.
A L	The Architect. *w.* 26*s.* London.
A M	American Machinist. *w.* $3. New York.
A M C	Amer. Mag. of Civics. *m.* $3. New York.
Am M	American Miller. *m.* $2. Chicago.
A M & I W	Am. Man. and Iron World. $4. Pittsburg.
A M S	Aust. Mining Standard. *w.* 30*s.* Sydney.
A R	Architectural Record. *q.* $1. New York.
A Rev	Architectural Review. *s-q.* $5. Boston.
A S	Age of Steel. *w.* $3. St. Louis.
A S I E	An. of Amer. Soc. of Irri. Eng. 1892-93.
A S M E	Am. Soc. of Mec. Eng. *m.* New York.
B	The Builder. *w.* 26*s.* London.
B A	The British Architect. *w.* 23*s.* 8*d.* London.
B B	Brick Builder. *m.* $2.50. Boston.
B I S	Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C	Boston Jour. of Commerce. *w.* $3. Boston.
B M	Banker's Mag. *m.* 18*s.* London,
B M A	Bankers Mag. of Australia. *m.* $3. Melbourne.
B T J	Board of Trade Journal. *m.* 6*s.* London.
B U W	Bul. of the Univ. of Wisconsin.
C A	Calif. Architect. *m.* $3. San Francisco.
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C & B	Carpentry and Building. *m.* $1. New York.
C E	Colliery Engineer. *m.* $2. Scranton, Pa.
C Eng	Canadian Engineer. *m.* $1. Montreal.
C G	Colliery Guardian. *w.* 27*s.* 6*d.* London.
Ch	Chautauquan. *m.* $2. Meadville, Pa.
C M	Century Magazine. *m.* $4. New York.
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Cos	Cosmopolitan. *m.* $1.50. New York.
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E E	Electrical Engineering. *m.* $1. Chicago.

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El.. .....Electrician. *w.* 24*s*. London.
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I A......Inland Architect. *m.* $5. Chicago.
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I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s*. Lond
I C B.....Carpenter and Builder. *w.* 8*s*. 8*d*. London.
IC T......Iron and Coal Trades. *w.* 30*s*. 4*d*. London.
I E.......Indian Engineering. *w.* 18 Rs. Calcutta.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv......Invention. *w.* 11*s*. London.
Ir Age..Iron Age. *w.* $4.50. New York.
I R W...India Rubber World. *m.* $3. New York.
Iry.......Ironmongery. *w.* 3*s*. London.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
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R C J....Railroad Car Journal. *m.* $1. New York
R E M....Railway Engineering and Mechanics *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York
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R W.....Railway World. *m.* 5*s*. London.
Ry T.. ..The Railway Times. £1. 5*s*. London.
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S A......Southern Architect. *m.* $2. Atlanta.
San......Sanitarian. *m.* $4. Brooklyn.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
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S E......Stationary Engineer. *m.* $1. Chicago.
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Sea......Seaboard. *w.* $2. New York.
S In......Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L......Steamship. *m* Leith, Scotland.
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S R......Sanitary Record. *m.* 10*s*. London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis
S P......Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V......Safety Valve. *m.* $1. New York.
T........Tradesman. *s-m.* $2. Chattanooga, Tenn
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
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Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
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ARCHITECTURE & BUILDING

Sky-Scrapers.

THIS facetious and somewhat satirical erm has been popularly applied to the tall uildings that are fast becoming the most onspicuous—certainly not the most graceul –feature of modern urban architeture. Taking it as a title, Mr. F.C. Gordon in *The American Architect* (Dec. 8) alleges that his class of structure has come to stay. No mount of protest will avail against it. The arge rentals such buildings return to their wners for a stated ground rent, as comared with lower buildings on the samericed lots, appeal so strongly to the noney-getting spirit of the age that these uildings find increasing favor. If one vere to seek for the best architectural exmplifications of this spirit and of the rule f supreme selfishness in the present age, he vould find them in the tall office-buildings nd the tenement-houses. In point of inrinsic beauty these two classes of buildings re about on a par. Let us be candid, hower, and admit that tall buildings serve vell as office-buildings, and that the favor vith which they are regarded by tenants is t least one valid reason for their existence.

In Mr. Gordon's view "the one utilitaian objection to very lofty buildings is hat they will cut off the daylight from the treets below. It is true, it would be very ndesirable to build them on both sides f a narrow street. But we have the ublic squares and parks surrounded by usiness streets, which would look all the nore noble if built up twenty stories to a epth of sixty feet; then dropping down o fifteen stories for forty feet, and after hat letting the limit of height be twelve, en, eight, or six stories, according to the idth of the streets. If all the public quares of New York were lined with venty-story buildings, much more than ie whole office community would be acommodated better than now, and, even om a distance (down the harbor, for inance), the profile would give a very imosing effect.

"The esthetic objection is that they are ugly and cannot be made beautiful. It would indeed be most regrettable if our cities were doomed to be filled with structures more ugly than those they already contain. But let us first inquire whether any really honest and earnest effort has yet been made to give consistent beauty to the 'sky-scraper.' How were the Greek temple and Gothic cathedral made beautiful? Chiefly by making them true, and by permitting the style to evolve itself naturally from the needs and conditions under which they were built. The first artist-builders of those noble structures used all the skill, knowledge, and fine sense of the beautiful of which they were possessed to make them delightful to the eye and monuments of man's genius for all time. But beauty alone was not the first or fundamental thought. Use and construction came first, ornament afterward, and the style was the inevitable outcome of the method of construction and the material used."

If the spirit of the time that has given birth to the tall office-building is to be embodied in its architecture, where is the opportunity for art? The amassing of more wealth by concentration of the power which wealth gives, and by its direction to that purpose alone, is already well expressed in the tall office-building, which goes on its way skyward regardless of aught but this single object. But, aside from artistic considerations, the practical results in the near future regarding street traffic deserve some attention. Mr. Gordon has evolved a scheme for proportioning the height of tall buildings to width of streets; but a difficulty arises. Neither the spirit of the age nor the uses to which such buildings are put will admit of such adjustment.

"First, the office-building is entirely and purely a place of business. There is room there for nothing else. *Utility* is, therefore, its first requirement. There must be all possible floor-space; abundance of direct light (not less than two-fifths of the outside wall-space should consist of windows); perfect provision for artificial light, heating, and ventilation; roomy corridors illuminated by direct light; and ample elevator-service, stairways, and fire-escapes. It must be fitted with all the conveniences that modern life insists on and has made possible; in short, it must have everything and be everything to enable every move of business to be a 'rapid transit.'"

It is to be all for business. Business dispatch and utility are the ruling motives. Such being the case, the tendency must inevitably be to localize these buildings, and cluster them around and near certain points, regardless of symmetry, regardless of anything but the money-getting they are intended to facilitate. This tendency to localization in business is too appaent to be lost sight of by even a superficial observer. In any large commercial town there will be a dry-goods district, a financial center, etc., each prominent business grouping around some favored spot, rarely a park or a square; and this is governed not by fancy or caprice, but by a law of trade. To get custom one must go where customers most congregate.

If a new city were to be built with a view to encourage tall buildings, with streets four or five times as wide as they are now, the tall building would not be so objectionable as it is, either in point of appearance or in its other features. It used to be thought in most large modern cities that the streets were inconveniently crowded; but tall buildings erected on narrow streets, attracting four or five times as many people as formerly, have rendered some streets at certain hours of the day well-nigh impassable. Had not facilities for street traffic in some measure kept pace with the increased crowding, some streets would have been hopelessly blocked before this time. With streets now appropriated by trolley- and cable-railway lines, the outlook for much increase in facilities for street traffic is not encouraging. But high building is still going on with great vigor, and twenty-story structures are not merely talked of,—they are planned and are going up. Is it not worth while to bestow some attention upon the condition of traffic on narrow streets that will surely come in the nea future?

The Reliance Building, Chicago.

THE lofty office-buildings which are going up in the large cities of the United States are attracting attention abroad, and naturally enough—the engineering problems worked out in their construction being their most interesting feature—this attention is manifested in publications devoted to engineering rather than architecture. Thus *Engineering* (London, Nov. 2) gave an illustrated description of the Reliance Building, Chicago.

This is truly a tall building, being fourteen stories, or 200 feet in height. Its breadth is only 55 feet, and this disproportion gives the building the appearance of a tower rising above the common level of the five-story buildings surrounding it. The reasons for the selection of this building as a type of tall structures in the United States are not very apparent, as it certainly is not among the best existing examples, and in external appearance it is not admirable. Probably the selection was influenced by the circumstances of its construction, which may seem somewhat extraordinary from an English point of view, but which have had numerous precedents on this side of the Atlantic.

Briefly, this is the history of its erection. The building was originally a five-story, very strongly built structure, the lower story being occupied as a bank, and the superstructure rented to various tenants. It was decided that, when the leases of these tenants expired (May 1, 1894), the building should be altered into one of sixteen stories.

The foundations and first story were taken out in 1890, and rebuilt according t the plans for the contemplated tall building, the superstructure being supported o screws while this work was in progress Meanwhile the original plans for a sixteen story building were modified, and it wa decided to make it only fourteen-story. I the spring of the present year the thre upper stories were taken down, and th building was continued from the secon ory, the tenants of the second story re- aining in it while the building was being ›mpleted.

The exterior of the building is of white ıameled terra cotta and plate glass, hich, together with its great height and sproportionate width, renders it con- ›icuous enough, if that was the motive of s designer. The modest four-story build- g with attic and dormer windows that ınks it on the left is a much more agree- ›le object to look at.

Some features of the construction ex- nplify the extent to which engineering ıters into the construction of modern uildings.

"For wind bracing, instead of tension ›ds, which have been used heretofore, it ʼas determined to put plate girders 24 ıches deep at each door between the out- de columns, thus binding the columns ›gether, and transferring the wind strain om story to story on the table-leg prin- iple. These plate girders are bolted to ıe face of the column, and form a per- ectly rigid connection with the column. he columns are in two-story lengths, and djoining columns break the joints at each oor. Every piece of iron in the construc- on, including all the roof beams, is ıoroughly fireproofed with porous fire- roofing. Each piece of fire-proofing round the column is wired to the column ith copper wire."

"The Z-bar column, with its horizontal ap-plates breaking the column in two at very story, was discarded in this building, nd a new column used, composed of eight ngles. The cast-iron columns so dear to ur British architects have been abandoned n all good work in the States, and have ed to the design of many different types of olumns built from rolled sections of steel. pecial attention is paid to the question of ıaking easy connections between the irders and these columns, and for most urposes standard connections are used,—a lan which favors cheapness of construc- on. A favorite type of column for office- uildings has been the Z-bar column men- oned above. The column which has re- laced this form in the new building is the esign of Mr. Gray, and consists of a number of angles riveted together. A large number of tests on full-sized specimens have been made at the Keystone Bridge Works with perfectly satisfactory results, and from these it has been found that for all sizes of columns the safe load can be taken to be $(17{,}100-57\,{}_{r})$ lb. per square inch, where *l* is the length and *r* the radius of gyration of the column, the ends of which are taken as fixed. The ends of this column were planed off and connected by means of vertical splice-plates."

It is claimed that the interior finish of this building, when completed, will be finer than that of any building yet erected in Chicago, which is claiming a great deal, as those who are familiar with the finer Chicago buildings will agree. The woodwork will be of mahogany, the floors of marble mosaic, the halls on first and second floors finished with colored, and those on other floors with white, Italian marble.

What is known as the "Durham" system of plumbing will be used in this building,—a system in which "risers, wastes, vents, and down-spouts are of wrought iron coated inside and out while hot with coal-tar varnish" and put together with screw joints.

The heating will be by steam from boilers in the cellar. What is known to the heating trade as the one-pipe system will be used. The steam for heating ascends to the top of the building through an 8-inch riser pipe. Thence it is led off through branches to distributing riser pipes, which lead down to the cellar again, and which not only convey steam to the radiator connections, but also carry down the water of condensation to a return system in the basement. The 8-inch riser rests on a pier at the bottom, and its expansion is altogether upward. The distributing risers have expansion joints, and are run under the fire-proofing material of the columns.

Evolution of American Architecture.

Architecture and Building (Nov. 24) contains a paper by Mr. J. W. Yost, read before the 28th annual convention of the American Institute of Architects, held last October. The subject is dealt with in a clearer manner than is usual with writers who let themselves loose on "styles," particularly when speculating upon the genesis of styles. Much that has been said upon this subject is such unintelligible gibberish as to prompt the thought that its authors did not themselves know what they were talking about, and that they were in search of something in architecture about as clearly perceived by them as would be the idea of the fourth dimension by a youth whose preliminary preparation for the conception of this idea has been ordinary school instruction in the first book of Euclidean geometry.

A good impression is produced by the avowed and deliberate exclusion of the words "order" and "style" from the title of the paper; yet, notwithstanding, these intrusive words will slip into the discussion, as though the wholesome resolution formed had not enough strength to bar them out. The point of the argument is that a truly American Architecture will ultimately be evolved "under the law of natural selection, by survival of the fittest," and that this law ("which has governed the production of every variety of architecture throughout history") will assuredly give to America, in the fullness of time, an architecture whose "character, when compared with that of all historic work, will be as broad as our own civilization is broad when compared with the civilization of historic times." Out of present heterogeneity is to emerge a characteristic unity and harmony, or rather (to use the definition of life given by a learned writer on psychology) "unity in multeity."

"No nation has heretofore existed possessing the multiplicity of wants we have. No people ever before possessed the personal freedom of taste and the ability to provide an expression for it that we have. No style of architecture has ever been produced under such a variety of climatic influences as this country affords. Never have the designers and the builders of any country had at their control such a varied supply of building materials and building appliances. Never have people of any age or clime possessed such a complete knowledge of what all previous periods have done, or had at their command such ready means of full communication with each other and everybody else. Probably no nation of people was ever made up of so great a variety of races, nationalities, and antecedent conditions as exists with us."

The progress of evolution out of this confused mass of tendencies, each of which will exert an influence, is outlined with much imaginative power.

"In the evolution of a national architecture under the law of natural selection by the survival of the fittest, and under the conditions prevailing in this country, we begin by the use of first one style, then another, and then another, always terminating the experiment by softening the lines of demarcation between them, just as the settlement of the country began, first with a colony from another, and then from another. All these colonies mingle, and soon the special characteristics of each begin to disappear. Then comes another colony and mingles with the others, the new immigrants having less and less influence upon the whole civilization in proportion as that which has come under the new environment becomes greater and greater in proportion to what comes from abroad, until by and by the volume of American civilization will be so vast in proportion to the importation of foreign influences that the importation will cease to be in any appreciable measure a disturbing element. The peculiarities of all the races and nationalities will merge into a newly evolved human entity known as American. If architecture be true to its principles as a delineator of ethnographic life, it must follow this same process of accretion, assimilation, of elimination and crystallization, until out of the architectural styles of all the world there will come, in its own good time, an expression composed of all, yet different from all, governed by new requirements and limitations; and it will be known as 'American architecture.'"

But this is not to be in our day. A century at least will be required to produce a marked and specific differentiation from existing and preëxisting types. In he meantime we have to learn "how to esign, what to design, and what may be sed for ornament," with the understandng that the search for answers to quesions thus raised must reach beyond "the lane of the merely necessary," and exend to the beautification of the useful. hus the esthetic side is evidently the ne from which the predicted evolution of merican architecture is expected to make s most characteristic advance.

Architects as Promoters.

IN a paper recently read before the Minesota Chapter of the American Institute of rchitects, Mr. Walter S. Pardee discussed e propriety of the promotion of building nterprises by architects. This question eems to be about on a level with that of e propriety of an active interest in polics on the part of the clergymen, and hould find its proper answer in conscience nd good taste. It is discussed from the andpoints of honor and profit,—honor on e architect's side and profit on both sides. If it will not dishonor the profession for n architect to promote a building enterrise; if it appears that it will be a profitble enterprise for the client; if there is nough in it to pay the architect for his me and thought; or if the client means go ahead with the enterprise after havg been informed by the architect of the al *nature of the scheme,—then we say, yes.* t is proper for an architect to promote a uilding enterprise."

Of the forms which promotion by an arhitect may take, the commonest is, peraps, "when an architect details to a proserous friend the delights inherent in a eautiful home, and suggests that this iend permit the architect to make such etches in perspective, and such outlines plan, as will awake in the friend and the embers of his family a strong desire to be ossessed of such a home." Another exmple is "when an architect asks the man f means, who owns a fine business corner, consider if it would be a good location r a business block or hotel." Again, an rchitect may take "a third party into his onfidence, whose duty it is to see the rospective client, and recommend that the interested architect be employed to do the work." A more effective form of promoting is "when the architect, having passed the first stages of progress, proceeds to interest his influential friends; lay plans for convincing the client or clients, either by his own efforts or those of his friends,—thus laying out a plan of work that he hopes will have the desired effect." A reprehensible mode of promotion, which we hope is rare, though Mr. Pardee thinks it far too common, is when the architect "maligns his rival, or by other dishonorable means proceeds to gain his point."

In general: "Judging from present practice and indications, an architect's promotion of a building enterprise is one of those special ways to obtain work that each man would like a monopoly of, but that should be free to all. Broadly considered and honorably conducted, it is probable that such a thing would be advantageous to the profession. It ought to aid in stamping out some of the evils that threaten us."

The Third Highest Tower and the Loftiest Statue in the World.

AN illustrated description of the tower of the new City Hall, Philadelphia, in the *Scientific American* (Dec. 15), gives particulars of this remarkable structure, and also of the lofty statue of William Penn, which is its crowning feature. The statue stands on a pedestal at the upper extremity of the tower, five hundred and two feet from the ground. It is "thirty-seven feet high, and weighs sixty thousand pounds. The sculptor who designed it is Mr. Alexander Calder. The statue is said to embody" the popular conception of Penn's character. In face and pose the figure is strong, though there is about it all a Quakerly air of gentleness and simplicity. He wears the Quaker garb of the seventeenth century, with long straight coat and loose knee-breeches.

"A full-sized figure was first modeled in plaster by Mr. Calder at the City Hall. This was then separated into fourteen horizontal sections and removed to the Tacony Iron Works, at Tacony, Pa., where the figure was to be cast. The castings were made direct from the fourteen sections, thus preventing any variation from the original design. The statue was cast in aluminum bronze, the walls of the statue averaging five-eighths of an inch in thickness. This work was accomplished without mishap, and no parts needed to be recast. The sections are provided with inside flanges three inches wide, and are pierced with one-inch bolt-holes. The bolts are also made of aluminum bronze, to guard against the galvanic action which would occur between bronze and a more electropositive metal.

" After the castings had received the finishing touches at the foundry, the sections were assembled in the court-yard of the City Hall and set up temporarily. The statue stood in this position for more than a year, and has been examined by many thousands of curious spectators. The principal dimensions are as follows:

" Height, thirty-seven feet; hat-rim, twenty-three feet in circumference; nose, thirteen inches long; hair, four feet long; shoulders, twenty-eight feet in circumference; waist, nine feet in diameter; legs, from ankle to knee, ten feet; feet, five feet four inches long."

The statue was hoisted in sections, first to a staging at a height of three hundred and fifty feet, and thence to the pedestal on which it stands. The picture of it in the *Scientific American* shows it on the pedestal temporarily erected in the City Hall, with a group of men at its foot. The cut strongly reminds one of the pictures of Gulliver and the Liliputians in " Gulliver's Travels." Another picture shows it on the tower, and the fastening is described as "a number of three-inch bolts passing through the base of the figure and the plate forming the cap of the dome," though exactly what is meant by the " base of the figure " is not definitely explained.

The "Cairo Building," Washington.

UNDER the title " An Architectural and Engineering Triumph," the *Inventive Age* gives an illustrated description of this building, the design of which shows that in the modern tall-building idea the beautiful or picturesque somehow still refuses to be embodied. The building is of the steel skeleton variety, 100x122 feet on the ground, and thirteen stories high. The architecture is said to be of the " Egyptian order," because there are a few features in it resembling what may be found in ancient Egyptian building, but this attempt to combine the very ancient with the very modern has produced an extremely incongruous—not to say absurd—result. The architect is also the owner of the building, and his " remarkable activity and artistic architectural skill " are said to have won him fame, though he is yet a young man.

" The Cairo is located on Q street, between Sixteenth and Seventeenth streets, and commands a beautiful view of the city with its environments. The front, for the first four stories, is composed of Indiana limestones; the upper portion a combination of the latter with buff brick, the whole finished off with an ornamental iron cornice projecting five feet beyond the plumb-line. In the center a square projection, forty feet in width, breaks at the fifth floor into two octagonal bays. These are connected at several stories by elaborately carved balconies upheld by delicate stone columns. At each front corner a square, tower-like projection runs the entire height of the big building. At the fourth and tenth stories there are balconies supported by huge griffin-like figures. At the eighth floor additional balconies extend from the corner towers to, and are connected with, the central bays. The principal entrance, reached by a broad flight of steps, is through a wide recessed archway," the arch being semicircular.

Balconies and a semicircular arch on a building of the " Egyptian order of architecture " seem about as incongruous as Egyptian hieroglyphs would be on a Roman temple. The picture of the building shows that the Egyptian features are confined to the " ornamental " (?) iron cornice and the first stories of the " tower-like projections," these projections being broader at the foundation than at the third story; and the iron-foundry is suggested by the cornice much more than the ancient architecture of Cairo, after which city the building is named. Doubtless the terior, which is intended to be used artly as a sort of family hotel, or board- g-house, and partly for apartment house- eeping, may be commodious and well dapted to these purposes; but the exterior not "a thing of beauty," and no amount f ill-judged and indiscriminate praise can ake it such.

THE German Emperor has rendered him- elf obnoxious to the artists in Germany y his treatment of Wallot, the architect of e new Parliament House at Berlin. The *merican Architect* (January 12th) says at while decorations and honors were bestowed upon clerks, contractors and foremen connected with the work, the architect was intentionally ignored, and that when he was selected by the Berlin Academy of Fine Arts as the recipient of one of its great gold medals, the Emperor struck his name off from the list of nominations and substituted that of a lady whose contributions had been rejected by the Academy. Subsequently, while in Rome, the Emperor spoke very slightingly of Herr Wallot's design. The united architectural societies of Germany vented their displeasure at the Emperor's treatment of a great architect by giving a Wallot banquet.

INDEX TO LEADING ARTICLES.

he journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*26712. The Reliance Building, Chicago. ll. (E–Nov. 2.) 2700 w.

27037. Evolution of American Architecture. . W. Yost (A & B–Nov. 24.) 4500 w.

*27459. The Construction of a Great Build- g.—Progressive Stages of the Work. Ill. rancis H. Kimball (E Mag–Feb.) 3000 w.

27464. A New Building Bill for London. . A. E. Woodrow (A A–Dec. 8.) 2400 w.

27465. The "Sky-Scraper." F. C. Gordon A A–Dec. 8.) 2500 w.

27503. Underpinning the Schermerhorn uilding Walls. Ill. (E R–Dec. 8.) 700 w.

*27511. Marble in Gothic Buildings (I C B– ov. 30.) 1600 w.

*27514. The Gothic Revival (I C B–Nov. 0.) 4200 w.

*27515. The Pointed Arch in the East (I C –Nov. 30.) 900 w.

*27516. Gothic Arches. Ill. (I C B–Nov. 0.) 1600 w.

*27517. The Pointed Arch. Ill. A. S. J. I C B–Nov. 30.) 600 w.

*27518. The Young Architect (I C B–Nov. 0.) 800 w.

*27555. Metallic Construction in America A L–Nov. 30.) 1800 w.

*27581. Tewkesbury Abbey. Ill. (B–Dec. .) 2200 w.

*27616. Architectural Practice in Relation to romoted Building Interests. Walter S. Pardee A B D–Nov.) 1600 w.

27617. Cast and Wrought Iron for Frame Vork of Buildings (Sc A–Dec. 15.) 1200 w.

27618. The Tower of the New City Hall, hiladelphia, Pa.—The Loftiest Statue in the Vorld. Ill. (Sc A–Dec. 15.) 1200 w.

27623. One of the Latest High Buildings.— merican Tract Society Building. Ill. (R G– ec. 14.) 1500 w.

27662. An Architectural Engineering Triumph.—The "Cairo," Washington. Ill. (I Age–Dec.) 1100 w.

*27676. Commercialism in Art. Ill. (B–Dec. 8.) 4500 w.

27679. A New Fireproof Construction. Ill. H. B. Seely (A A–Dec. 15.) 2000 w.

*27692. Sliding Roof for Theatres. Ill. (E E L–Dec. 7.) 900 w.

27707. Red Lead Paint for Iron. Ralph K. Wing (A & B–Dec. 15.) 900 w.

*27750. Trans-Atlantic Notes. Ill. Arthur Lee (S–Dec.) 1500 w.

*27752. The New Union Station at St. Louis. Ill. (S–Dec.) 2000 w.

*27761. The Victoria Hall of Geneva. Ill. Lawrence Harvey (A L–Dec. 7.) 1600 w.

*27762. Training of Architects. (Abstract.) Arthur Hill (A L–Dec. 7.) 900 w.

*27763. The New Boy-Architect. (Abstract.) Frank Caws (A L–Dec. 7.) 1500 w.

*27768. Acoustics in Buildings (I C B–Dec. 7.) 800 w.

*27772. Rural Architecture (I C B–Dec. 7.) 1700 w.

*27773. Slates and Slating (I C B–Dec. 7.) 400 w.

†27784. The Passing of Gothic Art. Conrad Bryant Schaefer (I A–Dec.) 2800 w.

27814. The Society of the New York Hospital and Its New House of Relief. Ill. (Sc A–Dec. 22.) 1300 w.

27815. The Manhattan Life Building. Ill. (Sc A–Dec. 22.) 1800 w.

27821. The Calculation of Hip and Valley Angles in Roof Work. Ill. C. A. P. Turner (E N–Dec. 20.) 1500 w.

27823. Wind Bracing in High Buildings. (Abstract.) Guy B. Waite (E N–Dec. 20.) 1600 w.

We supply copies of these articles. See introductory.

27867. Traveling Scholarships.—What Work Must Be Done by the Student. R. W. Gibson (A & B-Dec. 22.) 1900 w.

27913. Specification for Structural Steel Work. C. H. Blackall (A A-Dec. 22.) 3200 w.

27915. The Horses of Apollo. Ill. (A A-Dec. 22.) 1400 w.

*27923. Country Homes. Ill. T. Raffles Davison (B A-Dec. 14.) 3600 w.

*27934. Some Suggestions as to Theatre Architecture. Editorial (B-Dec. 15.) 3300 w.

*27949. Some Historic Landmarks of London. Ill. John Gennings (Ch-Jan.) 4500 w.

*27953. Modern Mosaics. Ill. Isabella De Barbieri (A R-Jan.-March) 1800 w.

*27955. A White Enameled Building. Ill. Charles E. Jenkins (A R-Jan.-March) 1800 w.

*27956. The Historical Monuments of France. Russell Sturgis (A R-Jan.-March.) 2500 w.

*27957. A History of Old Colonial Architecture. Ill. Montgomery Schuyler (A R-Jan.-March.) 15000 w.

*27982. Sancta Sophia. Review of a book by W. R. Lethaby and Harold Swainson (A L-Dec. 14.) 3000 w.

*27984. Metal Ceilings Artistically Treated (N B-Dec. 22.) 1000 w.

*27986. The Practice and Province of the Architect (Can A-Dec.) 1800 w.

28013. Tests of a Fireproof Material for Floors in a Modern Building. Ill. J. Hollis Wells (E R-Dec. 22.) 1300 w.

28014. Fowler's Specifications for Roofs and Iron Buildings (E R-Dec. 22.) 1200 w.

28041. American Tract Societies' 20-Story Office Building, New York City. Ill. (E N-Dec. 27.) 2500 w.

28043. High Buildings of Steel Skeleton Construction (E N-Dec. 27.) 3000 w.

*28063. Siamese Sacred Architecture (B-Dec. 22.) 2800 w.

*28064. A Roman Villa at Darenth Kent (B-Dec. 22.) 2000 w.

*28143. New Developments (From Building News.) (I C B-Dec. 21.) 1800 w.

*28147. Windows. Ill. Anon. (I C B-Dec. 20.) 1600 w.

*28148. Mosaics of Our National Cathedral. Anon. (I C B-Dec. 21.) 2000 w.

*28150. Days in Rome. A. D. (I C B-Dec. 21.) 1300 w.

28173. Brooklyn's Memorial Arch. Ill. (Sc A-Jan. 5.) 450 w.

28198. The Cathedrals of France. Ill. Barr Ferree (Cos-Jan.) 4000 w.

28252. A Tile Roof for an Electric Lighting Plant. Ill. (R G-Jan. 4.) 600 w.

28258. The McKaig Bill (A & B-Jan. 5.) 2800 w.

28268. A Syrian Temple Ruin. Ill. Charles A. Rich (A A-Jan. 5.) 4500 w.

28289. Decorative Iron Work.—The Product of the American Artist-Blacksmith. Ill. W. H. Eckman (I T R-Jan. 3.) 1500 w.

*28336. The Competitive Designs for the Paris Exhibition of 1900 (B-Dec. 29.) 4500 w.

*28337. Some Curious Features of Old Parish Churches (B-Dec. 29.) 3000 w.

*28342. Handrailing—I. A Simple System. Ill. W. Twiss. II. A Spiral Stair. Ill. III. Handrailing Simple and Complex. Ill. W. Twiss. IV. Handrailing. Ill. Ungula. V. The Tangent System. Nulli Secundus (I C B-Dec 28.) 5800 w.

*28348. Arabesques and Grotesques (A L-Dec. 28. 2000 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A-Began Feb. 1892—Ended Dec. 29, 1894—29 parts—15 cts. each).

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6, 1893—38 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. Ed. W. Hind (S-Began Jan. 1894—10 parts to date—30 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. (B B-Began Jan. 1894—12 parts to date—30 cts. each).

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21288. Theatres. Ill. (A A-Began April 14—9 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B-Began April—8 parts to date—30 cts. each).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (A & B-Began Oct. 13—4 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. Ill. W. J. Eden Crane (I C B-Began Nov. 9—3 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (A & B-Began Nov. 24—2 parts to date—15 cts. each).

27369. Foundations in and Unreliable Soils. J. Nelson (I C B-Began Nov. 23—Ended Nov. 30—2 parts—30 cts. each).

27924. The Modern Theatre of the Continent. Edwin O. Sachs (B A-Began Dec. 14—3 parts to date—30 cts. each).

27952. Christian Altars and Their Accessories. Ill. Caryl Coleman (A R-Began Jan.-March—1 part to date—30 cts).

27954. The Musical Ideals of Architecture. H. Toler Booraem (A R-Began Jan.-March—1 part to date—30 cts).

27983. Architectural Books. Herbert Batsford (A L-Began Dec. 14—Ended Dec. 21—2 parts—30 cts. each).

28018. Concretes, Cements and Mortars: Old and New. Fred T. Hodgson (B B-Began Dec.—1 part to date—30 cts).

28082. An Iron Residence Roof.—House of J. J. Astor. Ill. (E R-Began Dec. 29—1 part to date—15 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

The Deep-Waterways Raid on the Public Treasury.

THE *Railway Age* (Dec. 7) editorially onsiders the present widespread effort to urther deep-waterways projects as "a ublic danger." As evidence of the extrardinary number of these schemes now rojected, the following list, brought beore the Trans-Mississippi Congress at St. ouis in November, is presented. That all hese schemes were favored is shown by he "resolutions adopted without debate," s indicated.

"(1) Asking that the Illinois and Misissippi canal, known as the 'Hennepin,' eceive a sufficient appropriation annully from congress to speedily finish the ork. (2) Favoring liberal appropriations or deep-water improvements on the Texas oast, and also (3) appropriations to ascerain to what extent the rivers of Texas can e made navigable. Asking congress to rovide (4) for the construction of a deepater harbor at San Pedro, Cal., and avoring the improvement of (5) Oakland arbor, (6) Sacramento, (7) San Joaquin iver, and (8) Islay creek. (9) Favoring he continuous appropriation of money for he continuance of present improvements n the upper Mississippi river, and such ew ones as shall be needed, including redging and jetties so far as practicable. 10) Favoring the construction of a deepater channel of not less than twenty-one eet in depth, to connect the great lakes ith the Atlantic ocean by the way of the t. Lawrence; (11) also by way of the udson river; and the construction of anals (12) connecting Lake Superior with he Mississippi river, and (13) Lake Erie ith the Ohio river. (14) Favoring the ppropriation of sufficient money to inrease the depth of water in the harbor f Duluth to twenty feet. (15) Favoring egislative action in behalf of the prompt onstruction of the Nicaragua canal under ontrol and supervision of the United tates."

It is computed that to carry out all these schemes would cost about $750,000,000, "yet the list is far from complete." This is a very large sum. The basis of estimate is not stated, and therefore a verification is not possible; but it would be less surprising to find that the estimate falls below, than to find that it exceeds, what all these improvements would actually cost. Is the country prepared to accept this great burden? Probably the promoters of any of these schemes realize that all of them cannot be carried out; but each hopes that his particular one will come to the top when the budget is sifted out, and safety for any one lies only in the ostensible approval of all. In this way the singular unanimity with which the whole batch of projects was favored in the convention can be explained.

"Seriously, the growing demand upon the public treasury, from every section of the country, for the construction of ship-canals and of deep waterways where nature failed to locate them have become appalling in their magnitude, and threaten to load all taxpayers with heavy burdens for the benefit of limited sections and favored localities. Before the day of railways, the waterways were the necessary routes of commerce, and national appropriations for their improvement and increase were defensible. Now, when hundreds of steam-roads, built by private capital, parallel and cross all the rivers and girdle every lake, furnishing cheap and rapid transportation for every locality, no matter what its natural situation, there is no need or excuse for taxing the western farmer, the miner in the mountains, and the sheep-raiser on the riverless plains to build ship-canals and reconstruct rivers alongside of the steel highways which are already more than sufficient to carry all the internal commerce of the country."

Prof. Cohn of Göttingen, in the *Economic Journal* (London), is quoted to illustrate the current expense of maintaining deep waterways after they have been put in operation, and as sounding a note of warning. "The German waterways during the ten years 1881-90 cost the German government on an average 26,000,000 marks per annum against a revenue by tolls of 2,000,000. To this must be added interest on borrowed capital, etc., etc. This, at a yearly rate of 18,300,000, brings the former figure up to an annual expenditure (for Prussia only) of 36,700,000, against 2,000,000 of receipts. Thus nearly the entire surplus of the railway administration is swallowed up by the waterways. Traffic by inland navigation has so developed itself of recent years in Germany as to benefit more especially the larger firms, and that these should obtain gifts at public expense is a most perverted form of communism, since it compels the great mass of taxpayers to make sacrifices in the interest of the wealthy minority."

Prof. Adolph Wagner is also on record against what he styles the "*inverted communism* which calls upon the community, and especially districts which possess no waterways, and portions of the community which do not make use of them, to pay the vast cost of the waterways for the benefit of certain districts, places, and classes which do use them."

In France, also, there is a growing feeling of opposition to the injustice of the canal-building policy, which has been voiced in the *Journal des Débats* and other organs of public opinion. "At present the State is giving, so to speak, a bounty to those ports which it has furnished at public expense with inland water connection, and so turning aside to their profit a traffic which, but for that, would certainly fall to their rivals, who, as it is, bear the same burdens without enjoying the same advantages. The inequality is absolutely startling. The State is throwing its weight in on one side of a commercial struggle. There is but one possible solution,—the re establishment of tolls on inland waterways. Yet in this country the Erie canal, paralleled by numerous railways, is maintained by the State free of toll, and the national government is building canals and canalizing rivers at prodigious cost to be used free of charge by all who wish to engage in the business of carrying. It is indeed time that the attention of legislators and taxpayers in the United States were called to the abuse of governmental power which is encouraged and demanded by every waterways convention."

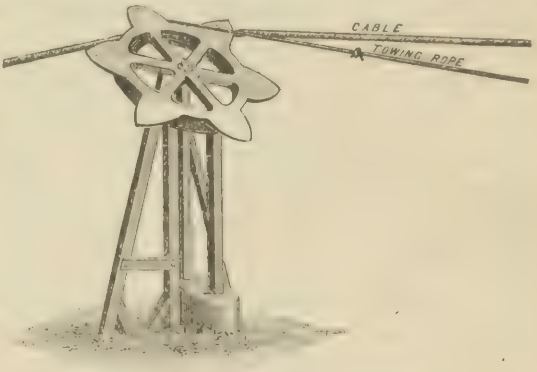
Cable-Haulage on Canals.

THE many attempts that have been made to render continuous haulage practicable on canals and the uniform failure that has attended previous efforts in this direction render the renewal of the effort, in France, all the more remarkable. It is, perhaps, the ingenuity of the device used as a solution of the problem that is most notable in the new method. An article in *The Engineer* (London, Dec. 7) describes and illustrates this device.

"The difficulty of preventing the escape of the cable from the pulleys offered plenty of scope for the ingenuity of engineers, and some of the most likely contrivances failed to act properly when put into practice. As events have since proved, this drawback would have been easily remedied if the cable could be made to run in a perfectly straight line; but in most installations there is scarcely a hundred yards of cable in which the direction has not to be changed by pulleys. The inequalities in the ground, the locks, the tunnels, and the curves in the canal necessitate a great many pulleys of various shapes and sizes, and these at first offered a serious impediment to the passage of the tow-rope attached to the cable. MM. Rigoni and Oriolle employed in their installations ordinary pulleys with smooth grooves, from which the cable was pulled away by the oblique strain of the boat. When at length this was overcome, a still greater difficulty presented itself in the awkwardness of turning corners by means of the cable. In the horizontal pulleys changing the direction of the cable away from the canal, and the vertical pulleys carrying the cable either over or under, the towing rope can pass easily without obstruction; but in many cases the cable takes an inward direction, with the result that it has to pass around the outer edge of the pulley. It was evident, therefore, that the horizontal pulley carrying the cable away from the canal would have to be suppressed, and some other system devised whereby the towing rope would continue to follow the cable without interruption. This difficulty has been overcome by M. Maurice Levy, inspector-general of *ponts et chaussées*, who has just prepared a voluminous report upon his system. M. Levy induced the government to authorize a trial of his system in 1888, when he laid down an installation upon the Marne, the Saint Maur, and Saint Maurice Canals, a distance of 5200 meters. This installation presented nearly all the difficulties that could be met with in such an undertaking, so that, if successful, there could be no question as to its efficiency for the general purposes of canal traction."

The experiment was tried first on a single section of the canal, and, this operating well, the government gave permission to complete the entire work. There were many special difficulties to be met. "This extension was a particularly awkward undertaking from the fact that it had to serve the port of Charenton, which has a length of two hundred and fifty meters, had to pass underneath a tunnel six hundred meters in length, had to go through the Gravelle lock, to which entrance is made extremely difficult on account of a bridge and a sharp curve, and had to cross a branch of the canal of Saint Maur by a single span of one hundred and twenty-one meters, to say nothing of the numerous curves that had to be met along the route. The installation comprises an endless cable that starts from the Gravelle lock, and, after following on one side of the canal, crosses at Charenton and returns on the other side. A second endless cable makes a similar circuit from the Gravelle lock to the river Marne by way of the Joinville tunnel. Special attention has been given to facilitating the attachment of the towing rope to the cable, and this is effected by the means of short lengths of rope that hang from the cable at regular intervals, and are provided with an ingenious clutch. The boatman can attach his tow-rope to the clutch in a few seconds without leaving the boat, and by merely pulling a lever the boat is loosened in a moment. The principal feature in this system is the ingenious method that has been adopted to prevent the cable slipping from the pulleys. This is done by constructing the pulleys, where necessary, with a serrated flange, so that the towing rope will enter one of the notches, and will leave it at the other side when the pulley has made a partial revolution. While plenty of freedom is thus left for the towing rope to pass over the pulley, the flange will prevent the cable from being pulled away. This principle has been developed to a singular extent at the curves, where the cable has to pass outside the support.

"The horizontal pulleys which at first gave so much difficulty have been replaced by oblique pulleys. In this new system the upper face is star-shaped, the flange bearing four or six prolongations that are made almost semi-circular in form, so as to facilitate the entrance and release of the cable. These oblique pulleys have a diameter inside the groove of two meters. Of course, in the position in which the pulley is placed, the cable exerts a constant strain upon the flange, but the star-like projections are made sufficiently large to preclude the possibility of the cable escaping."



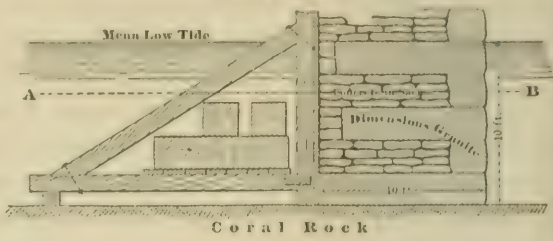
CANAL ROPE TOWING STANDARD

The illustration shows how the difficulty introduced by curves has been met. Of the degree of success achieved some doubt remains. It is the general opinion of engineers "that nothing could be more satisfactory if the cable could be worked in a perfectly straight line, but, where the cable has to be turned in different directions by pulleys of all shapes and sizes and sometimes placed two and three together, the friction must necessarily result in an enormous waste of power, to say nothing of the wear and tear of the cable. The installation upon the Saint Maur and Saint Maurice Canals has never passed much beyond the experimental stage, and the work which it has done has certainly not justified the cost of the installation. It is believed that the system can only be economical upon canals with a heavy traffic. With a traffic of a million tons a year the cable traction could be employed with great advantage, and from this point the economy would increase in proportion to the augmentation of traffic, until an economy of fifty per cent. could be effected upon the present cost of working, with a traffic of from three to four million tons. As there are many canals in the north of France fulfilling these conditions, the system is at the present moment being experimented with in view of its further extension, and it is likely that an installation will be laid down shortly on the canals in the Loire. The government of Holland is also carrying out experiments upon the Aisne Canal adjoining the Marne, where the first section has already been laid down in the Billy tunnel. Similar experiments have been carried out for some time past by the German government upon the canal from the Oder to the Spree, and the results are being looked forward to with great interest. Though the system has not so far been an unqualified success from an economical point of view, it is the opinion of engineers in France that it has a great future before it, and that it will be used extensively upon canals carrying a heavy traffic."

Sea-Wall at Fort Taylor, Key West, Florida.

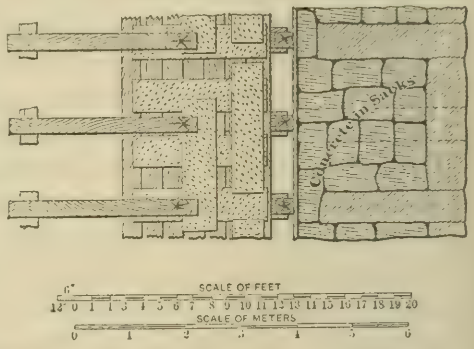
A NOVEL method of constructing a sea-wall at Fort Taylor is described in a paper by Lieutenant-Colonel Jared A. Smith in the *Journal of Engineering Societies* for November. When this paper was read, it elicited a spirited discussion, which, on the whole, seems to confirm the value of the innovation. This method, illustrated in the accompanying engraving, is, in substance, the use of dry concrete in partially-filled bags, which, after submergence, may be rammed to compact the concrete. If the bags are completely filled, they burst when rammed, but the allowance of about one-fourth unfilled space allows the ramming to be done thoroughly and safely.

Cross-Section.



Old gunny-bags that had been filled with sand for defences in war-time were employed. They were of very loose material, about three feet in length and two feet in width. Wet concrete has been used in bags, but this use of dry concrete for the purpose of rebuilding a sea-wall without a coffer-dam is probably, as Col. Smith thinks, the first recorded instance of this method of construction. The stones had also to be laid in mortar, and the problem of doing this under water was ingeniously solved. "The first stone, a long stretcher, was laid upon the bottom, a formation of coral, which had previously been cut in steps with level tops to receive the stones upon an even bed. To lay the stones in mortar was a problem. I purchased some narrow and very thin muslin, and had the masons spread one piece of muslin with mortar about half an inch thick, and laid another piece of muslin over the mortar, precisely as one would make a mustard plaster for the sick chamber. The men

Horizontal Section on Line A–B.



that were employed as laborers were all amphibious, I am certain, for without protection, save one or two flannel garments, they would go down to the bottom and stay until the average man would have been drowned; then they would come up for a minute or two, blow a little, and go down again.

"When the stone had been lowered nearly to the bottom, two men drew the sheets containing the mortar-bed under the stone, which was then put in place and rammed down thoroughly with long-handled rammers, the bottom being directed by one of the divers, in undress, and the top being worked by men on the platform. The locating and leveling of the stones are matters of detail, which need not now be described. When a header was laid, the mortar between sheets was wrapped entirely around the bed and build. When an entire course had been built in this way, the backing of concrete was put in. It was made of Rosendale cement and coral sand in the usual proportions. Some chips from the granite and fragments of bricks were used to complete the concrete mixture."

The wall was backed with a solid timber structure, as shown in the cuts. "The temperature of the water was about 84°. The dry bags were handed to the men below the water, who put them in place carefully and rapidly, and they were thoroughly rammed in single layers of a thickness of about six inches."

Several hundred bags were charged with the concrete, and then were placed in position and rammed immediately. "It was an amusing sight to see hands sticking up out of the water all along the line, passing down concrete bags, without the appearance of a head save at what seemed long intervals, when a man would come up and blow for a few minutes before returning to his work under water. In that way the concrete was placed until it was fully up to the level of the course of masonry, when the same process was repeated by putting on another course of stone and backing it with concrete. When the wall had reached the low-water level, the concrete was placed in the ordinary manner."

The cost of the concrete was $7.08 per cubic yard. The overseer at Fort Taylor states that this concrete, put down in 1874, is an entire success, having become much harder than the coral rock of the island. Col. Smith states that the wages of the "amphibious creatures" employed to put down the concrete were the same as those of common laborers.

The Force of Tornadoes.

An active discussion of the effects of tornadoes upon bridges and analogous structures, and the resisting power of the latter to lateral wind-pressure, was conducted in the correspondence columns of *Engineering News*, in the summer of 1893. Both theoretical and practical points were considered. The discussion has been revived in the same paper (Dec. 20) by an editorial which, after mentioning an instance of the destruction "of a 533-feet span of the Louisville and Jeffersonville Bridge under what was claimed to be an extraordinary wind pressure," calls attention to the meager knowledge of the pressure per square foot which winds may sometimes exert. Theoretically, air, moving at a given velocity, exerts upon a square foot of flat surface a pressure that may be computed; but it is impossible to state the velocity which winds produced by natural forces may attain. The "pressure per square foot which may be exerted by a tornado, ... in view of the rapid increase in steel skeleton buildings of great height, most of them built without wind-bracing, ... is certainly a matter of much interest to engineers."

"Perhaps the best evidence we have of maximum force exerted by a tornado is the well-authenticated case of the lifting of a locomotive from the rails at East St. Louis some ten or twelve years ago. The locomotive was lifted entirely clean off the rails and set down right side up at one side of the track, so as to make it certain that the force was sufficient actually to lift the locomotive, and not simply to overturn it. What would happen if a wind of such intensity should strike a modern ten-story or twenty-story office-building we leave our readers to compute, on whatever assumptions seem to them reasonable."

The further collection and recording of instances of great wind-force is recommended. Following the advice, a letter from James W. Way, chief engineer of the Missouri Pacific Railway, is presented. This letter contains a report prepared by the superintendent of the Iron Mountain Road Division, describing a cyclone that struck that line on the 12th of last September.

"The cyclone crossed the track about half a mile west of Charlestown, and, from a personal interview with the people living in the course of the same, they describe it as coming from the south, making a roaring sound and rolling like a large barrel tossing up and down. It was about forty feet wide, and took houses and trees as fast as it came to them; when it reached our right of way, on the south side, timbers and trees were being carried along with it. It then lowered to the fence and took it all away, and from there bounded to the rear coach of No. 47, throwing the car thirty feet from the track, the rear coach evidently dragging the balance of the train with it. The force was going upward and did not take our fence on the north side, nor did it come down until it reached a point two hundred feet north, when it again touched the ground, taking large trees and outhouses, and then rose and crossed our Belmont Branch without any damage. The train was running about eighteen miles per hour, and only ran thirty feet after being raised from the track. At the point where the derailment occurred, the track was first-class, with good sound ties. A large tree struck the side of the rear car, making a large hole. A board was blown through the engine cab window."

Mr. Way adds to the report the remark that these "twisters," as they are called in the region named, "are very peculiar, and their force is not direct. . . . On the contrary, they have a rotary motion which is irresistible." Upon this statement the comment is made that "certainly a force which is capable of picking up a locomotive may be described with considerable accuracy as 'irresistible'; and a force which catches up a passenger car and throws it thirty feet from the track might fairly be included in the same category." From a calculation based upon the estimated weight of the car, and the distance to which it was thrown, the conclusion is reached that a pressure of at least one hundred pounds per square foot must have been exerted.

Wind Pressure.

APROPOS of the discussion of "The Force of Tornadoes" in *Engineering News*, elsewhere reviewed, *The Engineer* (London, Nov. 30) has an editorial on "Wind Pressure," which further admits the need of more study of the subject and the collection of additional data relating to it. Speaking of the memorable collapse of a portion of the Tay Bridge, "with its attendant lamentable consequences," it says that, as a result, "engineers felt themselves obliged to examine theoretically and practically, and more closely than they had previously done, the phenomena associated with the action of the wind. It is not that the force, the violence, the impactive and the concussive effects of winds varying both in velocity and pressure, upon bridges, roofs, chimneys, and, in fact, all engineering and architectural structures exposed to their fury, were not previously recognized by scientific and technical writers, and even some allowance made for them by designers; but the whole question, which is exceedingly important, had certainly not received that attention and consideration which it unquestionably both deserves and demands. Engineers were accustomed to regard these effects in the light of perhaps possible but barely probable contingencies, which in the majority of instances were too remote and uncertain to be included as a factor in the calculations. It must be admitted that at that time there was a great paucity of real information,—that is, of information of a character which would permit of trustworthy deductions being made, and upon which could be based mathematical analyses and investigations resulting in tangible and workable conclusions. At the present time, notwithstanding the value of the evidence afforded by the construction

the Forth Bridge, there is a great defi-
ency in the experimental data connected
ith the subject ; although now sad expe-
ence has amply demonstrated that what
ere formerly considered as merely possi-
e, or extremely improbable, occurrences
ve passed into the category of those
ich have actually happened. For years
st most valuable and interesting meteo-
logical observations have been under-
ken and accurately recorded, both in our
n and other countries, which constitute
mass of highly useful data. From these,
connection with other known facts, the
lation between the velocity and pressure
the wind has been ascertained with a
ecision and fidelity which do not admit
controversy. But, while establishing
is generally received relation, the exact
lue of the coefficients are left undeter-
ned."

Moreover, it is shown that, in a calculation
wind pressure exerted upon a roof, the
ta are "so incomplete and indeterminate"
to require an assumption that "may vary
tween the somewhat wide limits of nine
unds and ninety-three pounds per square
ot." Pursuing the subject further, one
the reasons supposed to account for the
structive action of winds is in the iso-
ronism of the wind impulses with the
tructural vibrations set up." Certainly,
wind comes in puffs, keeping time with
vibrations it sets up in a structure, its
ce, added to the momentum of the
aying mass in the same direction, would
ke a sum of strain far beyond what the
nd by itself could exert upon the surface
an entirely rigid mass, such, for instance,
the face of a cliff. It is also thought
t more attention ought to be given to
effects of deflection of winds by local
nditions. "The separate and distinct
rrents formed by the interposition of an
movable surface to the natural path of
nd waves in their attempts to find an
tlet very often re-combine, and, aided by
tinuous reinforcement, ultimately as-
me a condition analogous to that of an ac-
nulated head of water. It is well known
t tremendous local pressures are pro-
ced from this cause, and it is possible that
unknown maximum may be yet found
under these conditions, though they are fortunately more exceptional than general." The effect of dead weight in neutralizing the *vis viva* of winds, and the fallacy of the belief that a girder of the open web type on the windward side of a bridge will effectually protect the one opposite to it on the leeward side, are pointed out.

Testing Water Service Pipes.

Engineering Mechanics describes an English system for testing water-mains and detecting leaky fittings in houses without entering the buildings. In this method, known as the "Deacon System," by an arrangement of stop-valves any particular street can be supplied from one main only, whilst the remainder are fed by the other. A Deacon water meter fixed on a by-pass to the service main measures the supply to the street isolated, as described above, and records it automatically on a strip of paper, moved by clockwork, whilst a couple of pens operated by an accurate clock also make marks on the same paper every six seconds. In practice, the turn-cock, before setting out for the isolated street, compares his watch with this clock, and on reaching his destination he proceeds to turn off house after house, noting the time at which each stopcock is closed. A comparison of this list and of the meter record the next day shows the houses having leaky fittings. It is stated that the method has proved quite satisfactory in practice.

Industries and Iron says that M. René Baudouy, concessionaire of the Salonica-Dedéaghatch-Constantinople line, has applied to the Government for the concession to build a railway between Feredjik where the Salonica line joins that of Dedéaghatch, and Rodosto, on the Marmora. The projected line would run through one of the most fertile and productive parts of the province of Adrianople.

THE Simplon Tunnel through the Pennine Alps is the subject of a series of illustrated articles begun in *The Engineer* Jan. 4, dealing with engineering features of this great work.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

†27637. Revised Plan of Light Suspension Bridge to be Erected Over Tuichoug River, South Lushai Hills. Ill. Banerji (I E–Nov. 10.) 900 w.

*27686. The Foundations of Newburn Bridge, Northumberland. John Henry Barker (C G–Dec 7.) 1100 w.

27812. The Hudson River Bridge (Sc A–Dec. 22.) 700 w.

*27991. The Tower Bridge. Ill. (I C B–Dec. 14.) 1000 w.

28008. Bridging the Hudson River at New York City. Editorial (E R–Dec. 22.) 1100 w.

28009. The Report of the Government Engineers on the Maximum Practical Length of a Stiffened Suspension Bridge (E R–Dec. 22.) 900 w.

†28027. Anas Bridge, Godra-Rutlam Railway. Ill. (I E–Nov. 24.) 700 w.

28216. Plate Girder Swing Bridge over Bronx River, New York City. Ill. (E N–Jan. 3.) 900 w.

Canals, Rivers and Harbors.

*27550. The Canal Aqueduct at Briare. Ill. (E–Nov. 30.) 2800 w.

27606. The Hamilton Water Power and Canal Scheme (C Eng–Dec.) 1000 w.

27608. Georgian Bay Canal and Lake Simcoe Water Power. Thomas C. Keefer (C Eng–Dec. 1.) 700 w.

27609. The "Deep Water-Ways" Raid on the Public Treasury—A Growing Danger. Editorial (R A–Dec. 7.) 1300 w.

27624. The Nicaragua Canal. Editorial (R G–Dec. 14.) 1400 w.

27625. The Manchester Ship Canal. Editorial (R G–Dec. 14.) 1200 w.

*27689. Cable Haulage on Canals (Eng L–Dec. 7.) 1500 w.

*27778. Canal from the Hunter River to Port Stephens, and Improvements in the Harbor of Newcastle. J. Rorison (A M S–Nov. 17.) 1500 w.

*27785. Concrete Construction in the Illinois and Mississippi Canal. Ill. J. W. Woermann (J A E S Nov.) 7000 w.

*27789. The Construction of a Sea Wall at Fort Taylor, Key West, Florida. Ill. Jared A. Smith, with Discussion (J A E S–Nov.) 2800 w.

*27790. Improvement of Cuyahoga River. Jared A. Smith, with Discussion (J A E S–Nov.) 800 w.

*27974. The Sault Ste. Marie Canal, Canada. Ill. (I & I–Dec. 14.) 800 w.

†27994. The Sirhind Canal and Its Difficulties. Ill. E. A. S. (I E–Nov. 17.) 1500 w.

28035. The Harlem River Canal. Ill. (R G–Dec. 28.) 800 w.

28244. The Work of Improvement of the Mississippi River. William Starling (T–Jan. 1.) 4800 w.

*28325. Sheffield and South Yorkshire Navigation Company (Eng L–Dec. 28.) 2300 w.

Hydraulics.

*27558. The Philæ-Assuan Dam Project. W. E. Garstin (A L–Nov. 30.) 2200 w.

*27565. Progress of the Cataract Construction Company's Works at Niagara (N–Nov. 29.) 800 w.

27830. The Danger of Tapping Water-bearing Sand Under Pressure (E N–Dec. 20.) 500 w.

†27995. Well Sinking Facts. F. J. E. Spring (I E–Nov. 17.) 800 w.

*28036. The Hydraulic Ram. C. E. Houghton (S J E–Dec.) 2800 w.

28042. The Discharge of the Niagara River. E. H. Ruffner (E N–Dec. 27.) 2400 w.

28179. A Paradox in Hydraulics—The Impact Pump. Ill. Gus C. Henning (A M–Jan. 3.) 2200 w.

*28197. The Flow of Water Through Glazed Pipes. Emmett Steece (P–Jan.) 400 w.

Irrigation.

*27458. Ancient and Modern Irrigation in Egypt.—Object Lessons of Practical Value. Ill. F. Cope Whitehouse (E Mag–Feb.) 3000 w.

*28045. The Voice of the Great West. (Irrigation discussed.) William E. Smythe (Mill–Dec.) 2000 w.

Miscellany.

*27484. Wind Pressure (Eng L–Nov. 30.) 2500 w.

*27593. A Formula for Pile Driving. Charles Haynes Haswell (I & I–Nov. 30.) 1100 w.

*27992. Brunel and the Thames Tunnel (I C B–Dec. 14.) 3200 w.

28034. The Simplon Tunnel. (Abstract.) Ill. W. G. Triest, Jr. (R G–Dec. 28.) 3000 w.

†28046. The Asphalt Question. S. F. Peckham (J A C S–Jan.) 3000 w.

28247. Influence of the Size of Grain on the Strength of Cement and of Cement Mortar (R G–Jan. 4.) 600 w.

28251. Substructures. (Extracts.) George S. Morison (R G–Jan. 4.) 5500 w.

Serials.

22670. The Iron Gates of the Danube. Bel von Gonda (Eng L–Began June 1—Ended Dec 21—6 parts—30 cts. each).

26914. Waterways vs. Railways (R A–Bega Nov. 16—5 parts to date—15 cts. each).

27521. The Engineering Improvement of th River Clyde. Ill. James Deas (E Rev–Bega Nov. 20—2 parts to date—30 cts. each).

28259. Dam Construction. Ill. A. R Beardsley (Am M–Began Jan.—1 part to date–30 cts).

DOMESTIC ENGINEERING

Storage of Rain-Water.

A SERIAL which has been running for me time in *The Builder* (London), under e title "Details of Rural Water Supply," ntains, in the issue of that paper for De- mber, useful information relative to the orage of rain-water, which in some loca- ons must be relied upon as the chief urce of potable water. In many places here rain-water is not the only potable ater conveniently obtainable, it is needed supplement other supplies in dry eather; and it seems to be generally greed by physicians and sanitarians that is more wholesome than the average of ater obtained from streams or from sur- ce wells, provided proper care is bestowed on its collection and storage. Tabula- d statements of the amount of annual infall are only of value as applied to the rticular localities for which the tabulated servations have been made; but the fol- wing rules may be used for computing e supply of water obtainable from a given llecting surface in any locality whose nual rainfall has been determined.

"1. Multiply the area in square feet by alf the annual rainfall in inches; the roduct is the quantity of water in gallons, pproximately (Parkes's 'Practical Hy- ene').

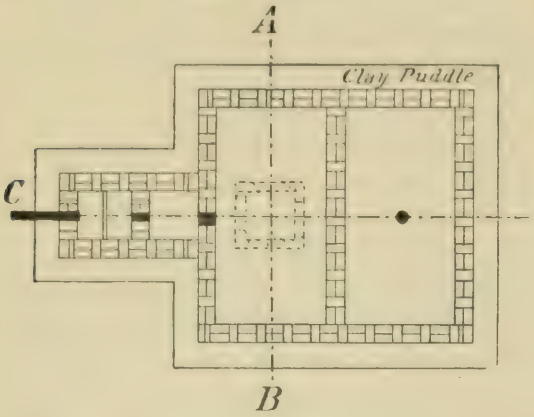
"2. Multiply the area covered by the of in square feet by the average rainfall, so in feet, and divide the result by one ndred; the product is the average sup- y in gallons *per diem* for a very dry year . Wallace Peggs, 'Transactions, Sanitary stitute,' vol. xlv).

"3. Multiply the lowest recorded rain- l in feet by the collecting area in square et by 0.015; the product is the average mber of gallons per day, including a all allowance for loss in the collection (Water, its Composition, &c.,' by Joseph rry, C. E.)."

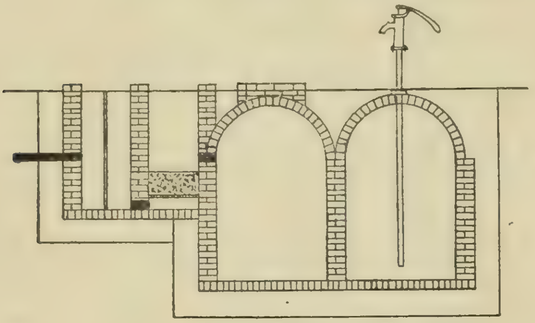
In applying these rules, what engineers l the "projected area" must be used; t is to say, the inclination of the roof does not increase the amount collected over what would fall on a flat surface having a width bounded on two sides by the eaves, and a length equal to the distance between the gable-ends.

Though rain-water is usually wholesome in rural districts, there may be conditions which will contaminate it. If the air contains polluting substances, they may contaminate the water falling through the atmosphere; and it is quite certain that in this way dust and small insects, as well as germs of bacteria, are sometimes collected during a period of violent rainfall. But these contaminations are rarely brought down in deleterious quantity except when the collection of water is made from roofs of buildings which are of a character, and are situated favorably, to collect and hold objectionable matters in dry weather, to be washed off at the first heavy rainfall. Thatch, felt, lead, and zinc, are specially to be shunned as collectors of potable water. Thatch and felt are of a nature to hold soot, dust, and germs, and rain-water has a solvent action upon lead and zinc, thus taking up a portion of these metals. Probably slate and tin are the best materials for roofs intended to collect water for domestic purposes, and the cleanliness of all roofs so employed should be carefully looked after, as the excrements of birds, bats, and other flying creatures are almost sure to be deposited upon them more or less.

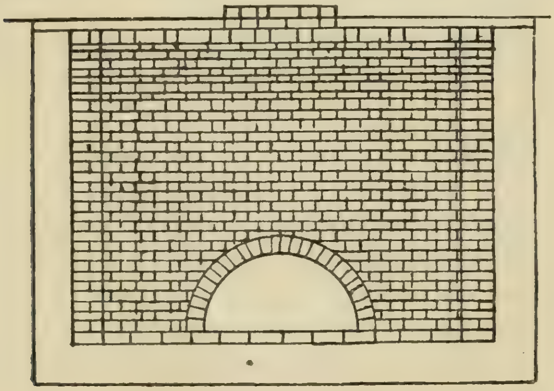
"The first portion of the rainfall collected from roofs, especially after a long period of dry weather, is usually of an impure nature, on account of the soot and other matters which have had time to accumulate. In order to prevent this portion from entering the storage tank, mechanical appliances, known as 'rain-water separators,' have been devised. These consist of vessels into which the rainfall is directed before passing into the storage tank, and which are so constructed as to collect the first portion of the flow, and, when full, to cant over, emptying their contents to waste, and at the same time placing the flow of water from the roof in direct communication with the storage tank. When the flow has ceased, they return automatically to their original position.



PLAN OF CISTERN.



Section C.D.



Section A.B.

"The rain-water may be stored in overground and underground cisterns, or reservoirs. The former have the advantage of enabling the water to be drawn directly by means of a tap, but are generally more expensive, and the water is subject to changes of temperature. The underground reservoir necessitates pumping, and is more liable to permit of pollution. The water should be strained through a copper strainer to keep back leaves, &c., and shoul be filtered before admission into the storage-tank. The filtering material may be sand, polarite, or other suitable substance. The tank should be efficiently ventilated, and have a sufficient covering of earth so that the water may be kept at an equable temperature; and should be, if possible, provided with a wash-out valve for cleansing purposes. When the roof surface is insufficient, a small area of ground may be fenced off, and either underdrained by means of agricultural tiles, or the surface may be covered with tiles or concrete, and the rain-water falling upon it taken by means of pipes to a storage-tank." The accompanying engravings illustrate the construction of a brick underground tank for storing rain-water, which is recommended for the purpose.

Gas-Heating for Greenhouses.

NOTWITHSTANDING the cost of gas as fuel for greenhouse heating, Mr. William Chester, in a recent paper (*Journal of Gas Lighting*, Nov. 27), expresses the view that, when all things are properly considered, it will compare favorably—at least in small installments—with any other system of heating. It certainly possesses the great advantage that its uniformity of action supersedes the necessity of an attendant to supply fuel at stated periods. Another advantage is the ease and certainty with which it can be made to maintain any required temperature by the aid of a thermostat. Thus artificial climatic conditions most favorable to health and growth of plants may be secured, and the different temperatures needed for the successful cultivation of plants native some to tropical, some to temperate regions may be easily maintained in different compartments of a conservatory.

"If we take a moderate-sized conservatory of the lean-to type, twenty feet long twelve feet wide, and ten feet high at the top, sloping to six feet at the eaves, we shall have a superficial area of glass amounting to about four hundred and fort square feet. Each square foot of glass surface is capable of cooling one and one fourth cubic feet per minute of heated ai i the interior of the conservatory to the emperature of the atmosphere outside ; so nat, with a glass surface of four hundred nd forty superficial feet, five hundred and fty cubic feet of air will be lowered to tmospheric temperature per minute. In rder to maintain constant temperature in ne conservatory, it will, therefore, be necssary to provide so much heat per minute s will raise the temperature of five hunred and fifty cubic feet of air the number f degrees which is the difference between ne interior and exterior temperatures of the ir,—say, about 30° F., in a conservatory here the normal interior winter temperaure required is about 50° F., and in a localy where the exterior temperature seldom oes lower than 20° F. or 12° below frost." f course in such situations "the atmosheric temperature often gets lower than 12° f frost ; but not in sheltered places, such s those in which conservatories are usually uilt.

"Now, five hundred and fifty cubic feet f air represents about forty-five pounds n weight ; and, the specific heat of air eing 0.2375 as compared with water, we nall require to develop as much heat as ill raise the temperature of 10.6 pounds f water 30° F. per minute, which is 318 ritish thermal units, or 19,080 units of eat per hour."

The heat in the system proposed is to e distributed by steam or hot water preisely as is now done when coal is used as uel, a boiler furnace specially adapted to ne use of gas as fuel being supplied. The ork above named could, it is estimated, e done with seven hundred and twenty ubic feet of gas per day, and, as the serices of an attendant are not needed, the ost of gas would be the chief expense.

"A specially constructed boiler, capable f maintaining the above high ideals, has et to be made. There are none which et come up to the mark, and some of nem fall very far short of it. The boiler ust be constructed with a studded botm and interior tubes with gills or studs n the inside for rapidly absorbing the eat and transmitting it to the water. It ust be of such length as to absorb all the eat developed by the combustion of the gas, except just the amount necessary to ensure a continuous upward current ; and it must be boxed in round the burner, so as to admit no more air than is just sufficient for the complete combustion of the gas. At the top it must be provided with a cover and flue-pipe for carrying away the products of combustion. The flow and return openings must be not less than the water-pipes to be heated,—say, three inches in interior diameter,—and the burner must be constructed to consume the maximum and minimum quantities of gas with perfect combustion. It must not fire back under any conditions ; and when not required it must automatically shut off all the gas except the supply to a small pilot jet, which will at once re-ignite the gas at the burner when further heat is required. The consumption of gas must be controlled by the temperature of the conservatory, and automatically increased or diminished within fixed limits, which may easily be determined. When we have such a boiler,—and there are no inherent difficulties in its construction,—we shall have a wide field for the further development of coal gas for conservatory heating. . . .

"My principal object in writing this paper is to direct the attention of makers into this particular groove. It will be a profitable one both for them and for the gas producer."

An experiment with a gas-burner of the "ring" type in a conservatory having 1956 square feet of glass and a cubic capacity of 19,162 feet, with heating pipes three inches in diameter and having a surface area of 431 square feet, and with a copper tubular boiler fifteen inches in diameter and two feet high (diameter of tubes one inch), enabled the building to be kept at a temperature of 66° F., with an outside temperature of 46° F. Sixty cubic feet of gas per hour were consumed to obtain this result. Water passed from the boiler at a temperature of 182° F. and returned to the boiler at a temperature of 87° F. In the installment, however, the following defects exist: "(1) The heating surface is deficient, the effluent gases being allowed to escape at too high a temperature. (2) Too large a proportion of air is permitted to enter with the gas. (3) The flow and return pipes at the boiler are much too small. (4) The radiating pipes are much too large for the boiler,—*i. e.*, a much larger boiler is necessary for effective work."

Sanitation of Hospitals and Infirmaries.

A PAPER recently read by Mr. Keith D. Young before the Architectural Association touches all the aspects of this subject. A rather unique division of hospitals into two classes attracts attention. One class is for private aid, the other for public protection. The first class includes those "devoted to the relief of the sick and injured poor." The second class comprises "hospitals for the treatment of infectious fevers," to which rich and poor may alike be removed when safety to the health of the community demands such a measure.

"The rules of hospital hygiene are in principle simple enough. That which makes the healthiest house makes likewise the healthiest hospital,—the same fastidious and universal cleanliness, the same never ceasing vigilance against the thousand forms in which dirt may disguise itself, in air and soil and water, in walls and floors and ceilings, in dress and bedding and furniture, in pots and pans and pails, in sinks and drains and dustbins. It is but the same principle of management, but with immensely greater vigilance and skill; for the establishment which has to be kept in such exquisite perfection of cleanliness is an establishment which never rests from fouling itself—not even the least odorous of such products—which ought not to be regarded as poisons."

"The air of a hospital ward is liable to contamination from the following causes: 1, the evacuations of effluvia from the bodies and excreta of patients; 2, the presence of suppurating wounds, with their necessary dressing, poultices, &c.; 3, foul linen bedclothes, &c. And these necessary and unavoidable conditions, common to all hospitals, may be aggravated and their danger intensified by: (a) insufficient air space; (b) insufficient ventiation; (c) inadequate or improper arrangements for the removal of refuse of all sorts; (d) faulty arrangement of buildings."

Striking examples of unsanitary conditions are cited, some of them so disgusting that their description is decidedly unpleasant reading. One of these—the old Hôtel Dieu in Paris, France—is stigmatized as a "monstrous pile more fit to prolong sickness, to destroy, than to re-establish and preserve health."

But the topic treated most at length is that of ventilation, in which the following prevalent faults, existing particularly in old hospitals, are enumerated,—insufficient air space, without which good and efficient ventilation becomes impossible, and insufficient supply of fresh air, less than two thousand cubic feet per hour for each patient being thus considered. In order that this amount of air may be supplied without unpleasant and injurious draughts, the space in wards should be so proportioned that the change of air will not take place more than three times per hour, which means at least one thousand cubic feet of space for each patient. But it is considered difficult to lay down hard and fast rules for apportionment of space. Natural ventilation, as distinguished from forced or artificial ventilation, is pronounced wholly inadequate for hospitals.

The sterilization of air from fever wards is of recent introduction, and is simply and easily accomplished at the Bradford Corporation Hospital. "Fresh air, capable of being warmed when necessary by passing over hot-water pipes, is admitted to the wards in the floor at the foot of each bed, and also at certain points in the opposite wall. The whole of the vitiated air is drawn from the ward through openings at the ceiling-level into a trench, at one end of which is a powerful furnace; part of this air is used to promote the combustion of the fire, the remainder being passed through the furnace and exposed to a temperature estimated to be 800 degrees F. All the windows in the ward are hermetically sealed. For sufficient reasons, I am not able to put before you any statistics as to the success of this system. The proof of success in an appliance of this kind is a matter for the bacteriologists and the miroscope; and we have yet to see whether ward constructed after this fashion fulls every requirement, not only of the sterization of the air, but also as a suitable lace for the treatment of small-pox. The oint, however, I wish to impress upon ou is that there is no justification whatver for applying such a system as this to ards for scarlatina, or any other infecous fever. The fact that scarlatina, the ıost important of these diseases, does not read beyond the walls of the ward is well ecognized; and, this being so, the necesty for any system of sterilization of air anishes."

Drainage is another point of equal imortance with ventilation. "In all sanitary ttings including sinks, lavatories, and aths, simplicity of form and cleanly appearance are desirable. They should also, as far as possible, be self-cleansing." Glass shelves are recommended for operation theaters where extreme cleanliness is of the highest moment. "For floors, the so-called fire-proof floor of carefully-laid terrazzo is the best thing to be had. A window should always be put between the end-bed and the end-wall. This may be as narrow as you like, but it must not be omitted." The reason assigned for this is the greater difficulty of effecting good air-circulation around beds placed in corners. The best wall-surface yet obtainable is Keene's cement surface, painted and varnished. The laundry should be isolated, as also should be the mortuary building, and the latter should have walls of glazed bricks and floors of asphalt.

INDEX TO LEADING ARTICLES.

he journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

*27563. The Heating of Greenhouses and onservatories by Coal Gas. William R. Chesr (J G L–Nov. 27.) 1500 w.

27802. Relation of Air Volume to Temperıure. Walter B. Snow (H & V–Dec. 15.) 500 w.

†27847. School Room Ventilation as an Instment. George Henry Knight (P S M–Jan.) 500 w.

27868. Improvements in Greenhouse Heatg. Samuel Burns (Met W–Dec. 22.) 3800 w.

27869. Heating and Lighting of Windsor astle (Met W–Dec. 22.) 500 w.

*27872. The Present Status of Steam and lot Water Heating. Leicester Allen (D E–ec.) 1100 w.

*27873. Overhead Heating in Greenhouses. l. J. P. Ring (D E–Dec.) 400 w.

*27874. Ventilation. Henry B. Baker (D –Dec.) 1700 w.

*27875. Hot Air Furnace Heating. Ill. (D –Dec.) 800 w.

27893. The Distribution of Temperature in team Heated Buildings. George De Witt (S –Dec.) 800 w.

28040. Pressure Hot Water Heating (Met /–Dec. 29.) 900 w.

28083. Hot-Water Heating Plant in a Brookn Residence (I. S. Coffin's.) Ill. (E R–Dec.).) 900 w.

28267. Heating of the Columbus Building Chicago. Ill. (E R–Jan. 5.) 1000 w.

Landscape Gardening.

27605. Imagination in Gardening. M. C. R. (G & F–Dec. 12.) 1600 w.

28155. Utility and Landscape. Sylvester Baxter (G & F–Jan. 2.) 1800 w.

Plumbing and Gas Fitting.

*27580. The Sanitation of Hospitals and Infirmaries. Keith D. Young, with Discussion (B –Dec. 1.) 10000 w.

*27871. A Remedy for Substitution. E. Baggot (D E–Dec.) 1000 w.

23269. Improved Method of House-Drainage. William Paul Gerhard (A A–Jan. 5.) 8000 w.

Miscellany.

*27774. The Site and Soil. Professor Carfield (I C B–Dec. 7.) 1000 w.

*27999. Healthy and Unhealthy Homes. Dr. Stirling (S R–Dec. 15.) 5500 w.

28352. Garbage Disposal. L. L. Summers (E E–Jan.) 800 w.

*28358. The Quality of Water for Domestic and Technical Purposes. Stephen J. Lett (S R–Dec. 29.) 7800 w.

Serials.

26907. Hot Water Heating and Fitting. J. L. Saunders (H & V–Began Nov. 15—2 parts to date—15 cts. each).

27214. Combination Heating. Ill. J. W. Hughes (Met W–Began Dec. 1—2 parts to date —15 cts each).

27783. Mechanical Heating and Ventilation Motors. Ill. M. C. Huyett (I A–Began Dec. —1 part to date—45 cts).

27848. The Names and Uses of Stops and Faucets. Ill. Calvin Fulton (S P–Began Dec. —2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

A Vast Electric Street-Railway System.

THE finest example of modern electric street-railway engineering in this country, or in the world for that matter, is undoubtedly that of the Philadelphia Traction Company, an admirable description of which, with many excellent and well-chosen illustrations, is given by Professor Hermann S. Hering in the *Electrical World* (Oct. 20, 27, Nov. 3 and 10). Want of space precludes mention of many interesting features of this enormous plant, but some idea of its dimensions and leading characteristics may be gained from the following synopsis. The company at present operates the equivalent of 119 miles of single-track road by electricity, 34 miles additional by cable, and 25 miles by horses. It contemplates the electrical equipment of all its present lines, and the extension of a number of new lines into the suburbs, at an early day, which will give an ultimate aggregate of about 300 miles. There are four power-houses, aggregating at present about 11,550 horse-power, but intended for an ultimate capacity of 19,800 horse-power. The largest of these stations is that at Thirteenth and Mount Vernon streets. The present equipment of this station comprises five Westinghouse vertical compound engines, each coupled directly to Westinghouse four-pole generators of 600 horse-power each. To these are shortly to be added four of the immense railway generators shown by the Westinghouse Company at the World's Fair of 1500 horse-power capacity each, driven direct by Wetherill-Corliss twin-tandem compound engines of equivalent capacity. The switchboard is 96 feet long and controls about 100 feeders, but has an ultimate capacity of 250 feeders. The weight of a 1500 horse-power generator, exclusive of the shaft, is 130,000 pounds. It runs at a speed of 80 revolutions per minute, and gives 2250 amperes at 500 volts. It works easily at its rated maximum capacity without heating or sparking at the brushes. Six of these immense machines are to be used by the company, four in the Mount Vernon street station and two in the station at Thirty-third and Market streets. Each of the four stations is provided with a testing room, equipped with a complete outfit of apparatus for testing the underground feeders and the cables through which telephone communication is maintained throughout the system. Very few electrical faults have occurred since the underground feeders have been placed in service. The general system of distribution adopted is that of supplying independent sections of the trolley-wire by means of independent feeders running directly from the power station, thus enabling any particular feeder to be cut out if necessary, without interfering with the running of the cars. The length of each detached section of trolley-wire varies from 1000 to 4000 feet. From three to five feeder connections are made with each section, and, in case of accident to any feeder, the corresponding section can be temporarily connected with the adjacent sections and thus supplied with current. A complete system of return feeders is installed in the conduits and connected with the rails at every manhole. These return feeders run to the switchboard at the power-station, so that practically very little of the current returns through the earth. Some of the feeders contain a very large amount of copper; one of the longest is over 16,000 feet in length, and has a cross-section of 700,000 circular mils. The return feeders are of twisted tinned copper wire, and have a cross-section at the station of 1,000,000 circular mils. There are 52 miles of return feeder cable.

The conduits are composed of a tough iron shell lined with smoothly finished cement concrete to a diameter of about 3 inches. These conduits or ducts are laid in bunches with about 3 inches of concrete between them, about 2 feet below the surface. The manholes are from 200 to 500 feet apart. The length of single duct aggregates about 800 miles. The street poles are of wrought-iron tubing, 28 feet in length and of various thicknesses according to circumstances. They are set 5 ½ feet deep in concrete. 15,000 of these are in use. The trolley-wires are of No. 0 hard copper, and the guard wires of No.6 silicon bronze wire, supported 18 inches above the trolley wire and 3 feet apart. Lightning arresters are placed on every feeder pole and connected to the return feeder, and a choking coil is placed between the feeder and the trolley wire. The track joints are lace-bonded with No. 0 tinned copper wire, fastened with channel-pins, and cross-bonded every 50 to 90 feet. The joint next to each manhole is tied to the return feeder. The number of cars now in operation is about 400, but it is expected that this number will be doubled in the near future. The average round-trip speed is about 12 miles per hour, and each car averages 130 miles per day. A novel feature of the car equipment is the engineer's test-car, which is furnished with a complete outfit of instruments and is used for inspecting the lines and making tests of the local conditions, both electrical and mechanical, in various parts of the system. Six tower-wagons are used by the company, each comprising a telescoping iron framework which can be raised with a windlass to suit the height of any wire. Each tower wagon carries a full outfit of tools for making repairs, and is kept ready at all times for instant service in emergencies. The station pressure used is 515 volts, and the average current per car in operation is found to be about 10 amperes, or about 7 horse-power, including loss in distribution. The greatest output of current hitherto observed was 6200 amperes for 2½ hours. Professor Hering includes among the illustrations a group of portraits of the engineering staff of the company, with brief notes of the professional career of each man. It is but just to say that it is not often that one sees so fine a group of heads brought together on one sheet. Each one is a notable specialist in his particular department, and has obviously been selected from considerations of merit alone. In conclusion it is not too much to say in praise of Professor Hering's article that it constitutes the most complete treatise on up-to-date electric-railway construction and management within our knowledge, and may be consulted with satisfaction and profit by every one interested in such matters.

Was Morse's Telegraph Invented by Morse?

THERE has been in late years, from time to time, no small amount of discussion as to the share of credit justly due the associates of Professor Morse for the invention of the modern electric telegraph which goes by his name. All the facts in the case, with one or two exceptions, have been so well established by contemporary evidence of unimpeachable character that there is really little or no dispute about them. Such controversy as there has been has mainly turned on the interpretation which is to be put upon these facts. A recent article by G. Wilfrid Pearce, published in *Electricity* (Nov. 21), attacks the claim of Morse in very intemperate language, to say the least, and in support of his position makes some positive statements which, in the absence of further evidence, may well be received with caution. For example, Mr. Pearce states that Morse was examined before "competent officers of engineers" in Paris, and "was obliged to admit that he was not the original inventor of the telegraph, and that the apparatus which he erected in the University of the city of New York was simply a copy of an apparatus which he had seen in Spithead, England." Again, the assertion is made that Morse "did not set about making apparatus until 1835," which is doubtless true as concerns the making of a complete apparatus, though there is good evidence that he made type for his transmitter at a date considerably prior to this; but this is bracketed with the assertion that at this date "there were long lines of telegraph in France which were better than Morse's, and equipped with almost all the devices which Morse attempted to use before Vail appeared on the scene and put the American lines into working order." If there are any historical grounds whatever for these remarkable assertions, it would be interesting to have Mr. Pearce tell us what they are, and especially why they have hitherto failed to come under the notice of painstaking historians. It has never, so far as we are aware, been doubted by impartial investigators that Morse was the actual originator of the first recording telegraph; that he conceived the idea on board the *Sully* in the autumn of 1832; and that he completed and exhibited a working model of the invention in the New York University in 1837. The real question—and it is one in respect to which there has naturally been much diversity of opinion—is whether the work admittedly accomplished by others, especially by Alfred Vail, ought rightfully to be regarded as a mere mechanical improvement engrafted upon Morse's original apparatus, or exalted to the status of a new and independent invention, of which Morse's concept furnished nothing more than the germ and the inspiration. The importance of this discussion lies in the fact that the telegraph of to-day has for the most part discarded as superfluous the very features which Morse was disposed to insist upon as most essential, while it has retained, and doubtless will permanently retain, many of those which were beyond question contributed solely by the genius of Vail. To say, as Mr. Pearce permits himself to do, that Professor Morse was a "Grand Master of Peter Funkism," is obviously not only unbecoming, but untrue. With all due respect to him, we do not think that the truth of history can be successfully vindicated by the substitution of epithets for evidence.

Test of Current-Controllers for Electric Cars.

THE method of controlling the current in operating street-car motors which was formerly employed by the General Electric Company consisted in using a plain rheostat, or artificial resistance, which was thrown into circuit at the moment of starting in order to prevent injury to the motor by too powerful a flow of current. As the car gained in speed, this resistance was gradually withdrawn, as the counter-electromotive force of the motor increased. In running at slow speeds, this device has proved very wasteful of current and consequently of coal at the power-house. Recently an improved method has been adopted, by which the two motors of the car, at the moment of starting, are placed in series with each other and with their respective rheostats. As the speed increases, the resistance is withdrawn, and then a shunt is thrown around each field. Next, the motors are placed in parallel, with half the resistance in, after which all the resistance is withdrawn, and finally, when full speed is reached, the motors are in parallel with shunts around both fields. The *Street Railway Review* (November) gives the results of tests of these respective methods of control, accompanied by graphic diagrams, showing the consumption of current in each method, from the starting of the car until a speed of about twenty-two miles per hour was obtained. The same car was used in both cases,—a sixteen-foot car weighing about fourteen thousand pounds. The time occupied in starting was about eighteen seconds. The diagram shows that the average amperes required during the eighteen seconds with the plain rheostat was 62.4, and with the series-parallel only 42.9,—a saving of about one-third. Another diagram shows that for speed varying from ten to fifteen miles per hour, with the particular car used, the average consumption of current with the plain rheostat was about 23 amperes, while with the series-parallel controller it was only abour 12.5,—a saving of about forty per cent. In addition to the economical advantages of the series-parallel controller, the smoothness with which a start can be made, and the facility of running at different speeds less than the normal, are very desirable features.

Electric Street-Railway Repairs.

IN the *Electrical World* (Oct. 20), Mr. J. B. Cahoon has a forcibly written article urging the importance of a careful and methodical accounting for the cost of repairs in street-railway service, and insisting upon the necessity of constant and vigilant inspection in every direction. He takes up each department in turn,—engines, boilers, dynamos, cars, motors, track, and line,—and demonstrates the vital importance of looking after all the innumerable details, the neglect of which causes an aggregate loss in the course of a year of an amount of hard cash not pleasant to contemplate. Among other things Mr. Cahoon strongly advocates the payment of firemen at least as much as $2 per day, besides a bonus in the shape of a percentage on the cost of all coal saved beyond a certain amount which is deemed a fair average for running the boilers to produce the steam required. It would seem to be obvious that, if a man's pay depends not on how much coal he can throw in the furnace, but on how much he saves, he will look very sharply after his fires, and will take an interest in the working of the plant which otherwise he would not. "Very few men," says Mr. Cahoon, "stop to think, when they see a leaky steam-pipe, that such leaks represent a direct loss in horse-power; they think it doesn't look very well, but that is about all the attention they give it. If they would, instead of looking at it in that way, only consider for a moment how much coal it takes to turn water into the amount of steam they see coming from such a leak, and recollect that every pound of coal costs money, they would see that it means a loss in dollars and cents and nothing else."

Dynamo-Electricity in Fire-Alarm Telegraphy.

SUPERINTENDENT B. S. FLANDERS, of the Boston municipal fire-alarm telegraph, in *Fire and Water* (Nov. 17), gives an account of certain experiments made by him in the application of dynamo-electric currents on his lines, which are of much interest. For the past year Mr. Flanders has employed a motor-generator driven by a 110-volt current derived from the mains of the Edison Illuminating Company. This machine feeds a group of six fire-alarm circuits, each of which is provided with a rheostat for adjusting the strength of its current. The average current required for each circuit is fifty volts and 0.04 amperes. The number of gravity-cells superseded by this arrangement was three hundred and fifty, and Mr. Flanders states that the capacity of the machine is ample to supply as many additional circuits. As to the results, he says: "The constancy and steadiness of the current thus obtained, together with the facility for instantaneously increasing or decreasing it to meet the varying conditions of the circuits, have thoroughly convinced me, after a trial extending through so many months, that the dynamo is greatly superior in all respects to any form of galvanic battery yet used in the fire-alarm service." The system has been definitely adopted for the new central station which is soon to be equipped under Mr. Flanders's direction.

Grade-Crossing on Electric Railways.

IT is encouraging to see that a State court has at last awakened to the necessity of prohibiting the crossing at grade of an established steam-railway line by an electric surface line. This happened in Pennsylvania, in a recent case which came up at Plymouth in that State, and a decree was issued by the court requiring the street-railway company to build an overhead bridge suitable for its own use and for ordinary travel on the highway in controversy. Although any action having the least tendency to increase the existing dangers at grade-crossings is directly contrary to the repeatedly expressed policy of Massachusetts, the courts of that State, in certain recent cases, have seemed to lean strongly towards the doctrine that municipalities have authority to grant a street-railway company the privilege of putting in such a crossing. Commenting on this state of affairs, the *Railroad Gazette* (Jan. 4) says: "The statutes and court decisions which have been the basis of the law hitherto were made on the assumption that street traffic is slow enough and manageable enough, and small enough in volume, to warrant some laxity or risk in the establishment and management of railroad crossings; and the reasonable limits of such laxity have probably been duly observed,—certainly as well in Massachusetts as anywhere else. But, as must be apparent to any one who stops to reflect a moment, the establishment of an electric line at once changes all these conditions. The cars are run faster than any street vehicles have before been run, and the rules about controlling speed and about the proper place to apply brakes on approaching a crossing are peculiarly liable to be disregarded, on account of the inexperience of the average motor-man. Unless a better grade of men are employed, this inexperience or its equivalent is likely to be a permanent factor in the case. And as every one knows [except possibly a judge.—Ed.], a place where the track is rough, as on a crossing, is just where the electric power is most likely to fail or make trouble. And finally, an electric line, suddenly increasing the speed and decreasing the cost of travel, often increases its volume very materially. These considerations make it highly necessary, not only in Massachusetts, but in every other State, that, where the laws do not adequately provide for safety at such crossings, they be at once changed so as to make the necessary provision." Something obviously ought to be done about this matter without delay, as the number of fatal casualties due to these death-traps is increasing at an alarming rate. As the Boston *Post* well says: "It is foolish, absurd, and reckless to authorize grade-crossings of electric and steam railroads, and, if the courts can stop it, the people will be thankful."

Automatic Cable Signaling.

In the *Electrical Engineer* (Dec. 19) Mr. Patrick B. Delaney gives an interesting *résumé* of the results of a series of experiments made by him last year on the transatlantic cables with a newly-invented signaling apparatus, which appear to have at length conclusively demonstrated the superiority of machine-working over hand-transmission. During a period of three weeks the entire traffic of the direct cable between Ballinskellegs and Halifax was transmitted by machine, the average rate of speed attained being 88 letters per minute, notwithstanding that there was an unusual amount of electric disturbance during the period, from natural causes. At a later date, the unprecedented speed of 243 words per minute was attained on the new (1894) cable of the Anglo-American company between Valentia and Halifax with carefully-timed regular commercial code messages. To appreciate the enormous advance which has been made in the art of cable signaling, since the beginning, it is only necessary to say that the best speed which could be got through the original Atlantic cable of 1858 never exceeded 2 1/2 words per minute, and, even after the successful cable of 1866 had been for some time in regular commercial service, 12 words per minute was considered a good average speed. Mr. Delaney has also experimentally satisfied himself that it is possible to effect automatic translation between the cable and the connecting land lines at each end, without appreciable loss of time in transmission, so that London may now write direct to Heart's Content, and New York direct to Valentia. He also predicts that the time is near at hand when direct automatic transmission will be established between New York and London at the rate of at least 100 letters per minute. A study of what has already been accomplished renders it impossible to resist the conclusion that Mr. Delaney's prediction is destined to meet with a speedy fulfilment.

The Metering of Multiphase Currents.

The rapidly-increasing application of bi-phase and tri-phase electric currents in electric-transmission plants has rendered radical modifications necessary in the construction of the apparatus hitherto employed for metering uniphase currents. In the *Electrical Engineer* (Jan. 2) an illustrated description is given of the metering apparatus designed by Mr. O. B. Shallenberger of Pittsburg for use in connection with the Niagara plant. The group of instruments comprises an alternating current volt-meter, an ampere-meter, a watt-indicator, and an integrating watt-meter. All these instruments depend for their action upon one and the same principle,—modified in minor details to meet the requirements of each specific application,—that of the induction of secondary currents in a movable closed coil.

Rights of Electric Companies in Public Highways.

THE *Electrical Engineer* (Nov. 7) publishes an abstract of a decision recently rendered by the Court of Appeals of the State of New York in a suit of ejectment originally brought by a property owner against a telephone company which had occupied a portion of the public highway in front of his premises with its poles. The court holds that compensation must be made to the owner of the fee for such use of the highway, and that an action in ejectment is maintainable, on the ground that the use is one outside of and beyond the public easement. The State, it seems, can neither appropriate to its own especial, continuous, and exclusive use, nor authorize any corporation to so appropriate, any portion of a rural public highway by setting up poles therein for the support of telegraph or telephone wires.

An Electric Locomotive for Heavy Service.

THE *Railroad Gazette* (Jan. 4) publishes a brief description, with two photographic illustrations, of an electric locomotive which has been built by the General Electric Company for the new belt line of the Baltimore & Ohio railroad, and is to be used for handling trains in the tunnel under the city of Baltimore. Two six-pole gearless motors, one on each axle, are flexibly supported on each truck. The driving wheels are of cast-steel, 62 in. diameter. The cab is spring-supported on the truck-frame, and contains the series-parallel controller and an air-compressor, driven by a small auxiliary motor, which supplies air for the brakes and whistle. The locomotive is of standard gage, is 14 ft. 3 in. long, and weighs 95 tons. It is calculated for a maximum speed of 50 miles per hour, which will be reduced to 15 miles per hour when the maximum draw-bar pull is exerted. The average speed with a loaded train will be about 30 miles per hour. A recent test of one of the completed trucks, being half the complete locomotive, in a tug-of-war with a heavy six-coupled engine of the New York Central railroad, demonstrated that for the same weight on the drivers the electric will start a heavier load than the steam locomotive, for the reason that with the former the pull is constant through the entire revolution of the wheel, the difficulty of variation of pull with the angle of the crank in the steam locomotive being eliminated.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Lighting.

*27564. The Fire Risks of Electricity (J G L–Nov. 27.) 1700 w.

*27576. The Electricity Works at Bedford. Ill. (E E L–Nov. 30.) 5000 w.

27600. Electric Lights and Power in Boston's State House Extension (E R N Y–Dec. 12.) 400 w.

27708. Electric Lighting for Small Towns (T–Dec. 15.) 2200 w.

27808. The Louisville, Ky., Electric Light Company's Station Extension. (Ill. (E E N Y–Dec. 19.) 1000 w.

27816. Constitution of the Electric Arc. L. Thomas (Sc A S–Dec. 22.) 1000 w.

27842. Christmas and Electricity. Ill. (E W–Dec. 22.) 3000 w.

*27899. The Electricity Works at Cardiff. Ill. (E E L–Dec. 14.) 4500 w.

*27907. Electricity for Towns' Use: Where Shall It Be Generated? Walter J. May (Inv–Dec. 15.) 1000 w.

*27927. Dioptric Glass Shades. Ill. A. P. Trotter (E R L–Dec. 14.) 2500 w.

28162. The Making of the Incandescent Lamp. Ill. (E E N Y–Jan. 2.) 2800 w.

28271. Arc Light Carbons. B. F. Miles (E W–Jan. 5.) 2800 w.

28272. The Incandescent Lamp. Ill. Manning K. Eyre (E W–Jan. 5.) 6000 w.

*28310. Proposed Regulations for Electric Light Installations in Germany (E E L–Dec. 28.) 1400 w.

*28329. Industrial Lamps. Anon. (C G–Dec. 28.) 1200 w.

28360. The Frankfort, Germany, Municipal Electric Light Station. Ill. R. Haas (E E N Y–Jan. 9.) 2000 w.

Power.

*27461. Electric Power for Isolated Factories.—The Original Cost and Advantages. Ill. William A. Anthony (E Mag–Feb.) 3000 w.

*27569. The Direct Conversion of the Chemical Energy of Carbon into Electrical Energy. W. Borchers (El–Nov. 30.) 1800 w.

*27587. Alternating Current Motors. Rankin Kennedy (E R L–Nov. 30.) 800 w.

27654. Some Notes on Multiphase Power Transmission. Ralph D. Mershon (E W–Dec. 15.) 1500 w.

†27663. New Sources of Electric Power. I. Electric Energy Direct from the Coalfields. B. H. Thwaite. II. Electricity from Peat. J. Munro (N C–Dec.) 6000 w.

27702. The Power Transmission System at the King Powder Mills. Ill. (E I–Dec.) 700 w.

†27730. Discussion in New York on Paper by Samuel Reber—"The Theory of Two and Three-Phase Motors" (T A I E E–Dec.) 4200 w.

†27731. Discussion in New York of Mr. Steinmetz's Paper on "The Theory of the Synchronous Motor" (T A I E E–Dec.) 3300 w.

27860. Improvements in Storage Batteries. Maurice Barnett (E M J–Dec. 22.) 2400 w.

28023. Recent Electric Plowing Experiments in Germany. Ill. (E E N Y–Dec. 26.) 1000 w.

28124. The Electric Locomotives for the Baltimore Tunnel. Ill. (E R N Y–Jan. 2.) 700 w.

28273. Storage Batteries. Ill. J. Appleton (E W–Jan. 5.) 1800 w.

28274. A Central Station Dynamo. Ill. J. B. Cahoon (E W–Jan. 5.) 1800 w.

*28311. Some Possibilities of the Storage Battery. Pedro G. Salom, in Cassier's Magazine (E E L–Dec. 28.) 3800 w.

Telephony and Telegraphy.

27015. The Columbia Telephone System. Its Factory and Instruments. Ill. (Sc A–Nov. 24.) 800 w.

26956. A Resurrected Chapter in the History of the Invention of the Telegraphh. G. Wilfred Pearce (E N Y–Nov. 21.) 1700 w.

*27568. Experiments in Cable Signalling. Patrick B. Delany (El–Nov. 30.) 1000 w.

27660. Telephoning Minus a 'Phone.—Alleged Discovery of Walter Wilhelm (B J C–Dec. 15.) 800 w.

27781. Origin of Telegraphing Through Water Without Wires. Victor M. Berthold (E R N Y–Dec. 19.) 1500 w.

27782. A Telephone in His Hat.—Ingenious Device of a Chicago Lawyer to Get Evidence Directly to a Detective's Ear. Ill. (E R N Y–Dec. 19.) 600 w.

27810. Experimenting in Cable Signalling. Patrick B. Delany (E E N Y–Dec. 19. 1000 w.

27865. The Berliner Patent Void—Important Decision Against the Bell Telephone Company (E A–Dec. 23.) 3000 w.

27910. The Cost of Telegraphic Blunders. R. D. Fisher (E N Y–Dec. 26.) 1400 w.

27911. The Telephone Question—The Effect of the Berliner Decision on the Industry (E R N Y–Dec. 26.) 5000 w.

27928. The Telephone Patent Situation. Ill. (E W–Dec. 29.) 1100 w.

28075. Electric Cables—Only Light Subaqueous Cables Manufactured in this Country (B J C–Dec. 29.) 1600 w.

*28315. Peculiar Telephone Troubles Caused by Alternating Current Distribution. E. W. Mix (El–Dec. 28.) 1300 w.

*28316. The Gilgit Telegraph Line (El–Dec. 28.) 1300 w.

*28320. Muirhead vs. The Commercial Cable Company. Editorial (E–Dec. 28.) 3800 w.

28361. The Callender Automatic Telephone Exchange System. Ill. (E E N Y–Jan. 9.) 4000 w.

Miscellany.

*26659. Modern Theories as to Electricity. What Is It? Whence Its Power? Henry A. Rowland (E Mag–Jan.) 3500 w.

26818. A Method of Distribution with Equalization of Potential Difference. D. H. Keeley, with Discussion (C Eng–Nov.) 5300 w.

*26942. The Electric Conductivity of Pure Water. J. W. Rodger (N–Nov. 8.) 1400 w.

*27468. Electricity Up to Date.—Electric Bells—Wiring and Connecting Up. Ill. (Iry–Oct.) 1300 w.

*27567. The Localization of Faults in High Tension Networks. F. C. Raphael (El–Nov. 30.) 1700 w.

*27570. On Villari's Critical Point in Nickel. Adolf Heydweiller (El–Nov. 30.) 1000 w.

27653. Electric Conversion System.—Devised by Ludwig Gutmann (W E–Dec. 15.) 1100 w.

27656. A Method of Determining Induction and Hysteresis Curves. Frank Holden (E W–Dec. 15.) 600 w.

*27693. Testing Practice in Electrical Engineering. Editorial (E R L–Dec. 7.) 800 w.

*27694. Dr. Borcher's Gas Battery: A suggestion. Legh S. Powell (E R L–Dec. 7.) 900 w.

27705. Electro-Plating Plants. Ill. H. G. Brownell (E I–Dec.) 1800 w.

27720. The Electric Problem with Reference to Fires and Firemen. G. P. Lowe (A G L J–Dec. 17.) 1500 w.

†27732. Discussion in Chicago of Elmer G. Willyoung's Paper on "Standardizing Electrical Measuring Instruments" (T A I E E–Dec.) 1300 w.

†27733. On the Production of Rotary Magnetic Fields by a Single Alternating Current. Ill. Ludwig Gutmann (T A I E E–Dec.) 4500 w.

*27759. I. Increase of Open-Circuit Loss in Transformers with Time. G. W. Partridge.

II. Note on Mr. Partridge's Paper. J. A. Ewing (El–Dec. 7.) 800 w.

*27760. Phenomenon Observed with Broken Magnets. Ill. (El–Dec. 7.) 1100 w.

†27792. An Apparatus for Exploring Magnetic Fields as to Direction and Intensity. Ill. W. E. Geyer (S In–Oct.) 2000 w.

27805. Locating a Bullet in the Human Body—Detecting Counterfeit Coins—Testing the Acuteness of Hearing. Ill. Nelson W. Perry (E N Y–Dec. 19.) 3000 w.

27809. The Manufacture of Chloride Accumulators. Ill. (E E N Y–Dec. 19.) 1800 w.

27843. A Practical Method for Measuring Rapid Changes in Current. Walter E. Harrington (E W–Dec. 22.) 700 w.

27931. Sparking of Closed Coil Dynamos. George T. Hanchett (E W–Dec. 29.) 1600 w.

*27977. The Life and Inventions of Thomas Alva Edison. Sylvanus P. Thompson (El–Dec. 14.) 3500 w.

*27978. Time Increase of the Open Circuit Loss in Transformers. J. A. Fleming (El–Dec. 14.) 1000 w.

28093.—75 cts. Non-Arcing Lightning Arresters. Ill. Alexander Jay Wurts (T Q–July.) 10000 w.

*28116. Experimental Investigations into the Origin of Frictional Electricity. C. Christiansen (E R L–Dec. 21.) 1800 w.

28160. Thermo-Electricity—Detecting a Difference of Temperature of One Five-Thousandth of a Degree—The Bolometer and the Measurement of the Temperature of Starlight—One One-hundred-thousandth of a Degree of Temperature. Ill. Nelson W. Perry (E N Y–Jan. 2.) 3000 w.

28163. Shallenberger's New Alternating Current Meters and Indicators. Ill. (E E N Y–Jan. 2.) 1600 w.

28165. How Does Electricity Kill? F. A. La Roche (E E N Y–Jan. 2.) 1900 w.

28270. Reminiscences of By-Gone Electrical Days. Fred. A. Scheffler, in Cassier's Magazine (A G L J–Jan. 7.) 3400 w.

*28309. On the Effect of Magnetization upon the Dimensions of Iron Rings in Directions Perpendicular to the Magnetization, and upon the Volume of the Rings. Ill. Shelford Bidwell (E E L–Dec. 28.) 1200 w.

*28324. Accidents in Public Electric Supply Mains. Anon. (Eng L–Dec. 28.) 1400 w.

28362. What Constitutes Insurance? H. G. Tuckermann (E R N Y–Jan. 9.) 1500 w.

Serials.

9771. What Is Electricity? Sydney F. Walker (E E L–Began Jan. 6, 1893—7 parts to date—30 cts. each).

16631. The Scientific Study of Arc Lamps, Ill. Rankin Kennedy (E R L–Began Oct. 6, 1893—9 parts to date—30 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (E W–Began May 19—23 parts to date—15 cts. each).

23866. Electrodynamic Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W–Began July 21—21 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A–Began Aug. 25—17 parts to date—15 cts. each).

25095. Postal Telegraphs. Ill. James Bell. (E L–Began Sept. 7—17 parts to date—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y–Began Sept. 19—16 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (E L–Began Oct. 5—13 parts to date—30 cts. each).

25897. The Velvo Battery with Mechanical Depolarization (E L–Began Oct. 5—Ended Nov. 30—2 parts—30 cts. each).

25907. The Alternating Current; Its Generation and Distribution. Ill. George D. Shepardson (E I–Began Oct.—3 parts to date—15 cts. each).

25954. Electric System of the Philadelphia Traction Company. Ill. Hermann S. Hering (E W–Began Oct. 20—Ended Nov. 10—4 parts—15 cts. each).

26592. Electrical Power Transmission. Ill. Louis Bell (E W–Began Nov. 10—7 parts to date—15 cts. each).

26945. Electricity on Board Ship and Its Application as Motive Power for Auxiliary Machinery. Alfred H. Gibbings (E L–Began Nov. 9—Ended Nov. 30—4 parts—30 cts. each).

27371. The Electric Light. Ill. Henry Stooke (I C B–Began Nov. 23—6 parts to date—30 cts. each).

27506. Suggestions in Preparing Specifications for the Electric Lighting of Buildings. Nelson W. Perry (E R–Began Dec. 8—2 parts to date—15 cts. each).

27599. Direct Current Motor and Dynamo Design. Ill. Gano S. Dunn (E N Y–Began Dec. 12—3 parts to date—15 cts. each).

27670. The Cologne Electric Lighting Station. Ill. (E–Began Dec. 7—Ended Dec. 21—2 parts—30 cts. each).

27704. Some Hints on the Building of Electric Plants. Charles G. Armstrong (E I–Began Dec.—1 part to date—15 cts).

27757. Induced and Impressed Electromotive Forces. Ill. (E L–Began Dec. 7—1 part to date—30 cts).

27804. The Commercial Possibilities of Accumulators for Tramcar Traction Considered as a Municipal Undertaking. Alfred H. Gibbings (E N Y–Began Dec. 19—Ended Dec. 22—2 parts—15 cts. each).

27855. Methods of Determining the Efficiency of Dynamos and Motors. J. Reginald Ashworth (E P–Began Dec.—1 part to date—30 cts).

27912. What Is Electricity? P. H. Vander Weyde (E R N Y–Began Dec. 26—1 part to date—15 cts).

INDUSTRIAL SOCIOLOGY

The Work of the Beer Money.

THE *Contemporary Review* has in a recent number a paper, entitled "The Work of the Beer Money," written by Mr. John Rae.

The selection of the title is explained in the first paragraph. "In the budget of 1890 Mr. Goschen put an additional sixpence of duty on the gallon of spirits, and set it apart, along with threepence a barrel of the existing duty on beer, as a subvention to local authorities to be devoted one-third, or nearly so, to providing pensions for the police, another third, or nearly so, to compensating publicans for the extinction of their licenses, and the residue to the reduction of their local rates. But the fund was no sooner created than the greater part of it was snatched from its original objects by a sudden gust of opinion and diverted to a more liberal destination.

"The representatives of the new technical education movement, headed by Mr. Arthur Acland, contrived to secure for county councils the option of applying the residue, if they so chose, to the promotion of technical education instead of the reduction of rates. Out of that option, originating in this almost accidental way, and conceded with probably little expectation of such a self-denying ordinance being actually exercised to any general extent, there has sprung up a movement of remarkable interest and activity in every county and borough of Great Britain; and the result is that more than four-fifths of the residue of the beer money (as this fund is popularly called, though much more of it comes from spirits than from beer), instead of going to the relief of the rate-payers, is now being spent by the representatives of the rate-payers themselves in furnishing the people with every variety of technical instruction."

We can now understand that the educational effect upon the English people of this expenditure of money raised by a tax on spirituous liquors is what is meant by "the work of the beer money," and that this has been important is made very evident before we read far. The economic proposition is made that "there is no better way of relieving rates than to enlarge the volume of wealth rated, and no better way of enlarging the volume of wealth rated than to increase the efficiency of the producers." After three years, in which the system has been undergoing probation, the status of the movement is as follows: About £1,350,000 is raised and divided,—80 per cent. to England, 11 per cent. to Scotland, and 9 per cent. to Ireland.

In Ireland the entire fund is devoted by statute to educational purposes. The Irish share is about £121,000, and of this sum about £78,000 goes to the national elementary schools, and the remainder to intermediate schools for payment of fees dependent upon the results of public examinations of students, payment of prizes, exhibitions, and giving of certificates to students. The residue is stated to have almost doubled the funds at the disposal of the Commissioners of Intermediate Education. The beneficial effect of this expenditure has been marked; but it is further stated that observation of the effect upon technical education in England has led to a movement for the establishment in Ireland of technical schools such as exist on the opposite side of the channel, where their success and usefulness are unquestionable.

"In England and Wales the residue the first year was £740,376, and of this £236,242 was applied to the extinction of rates. Not more than £150,000 are now applied to that purpose, the remainder being applied to educational purposes. England and Wales, exclusive of London, last year received more than £600,000 of the beer money, and only appropriated £35,000 to rate-payers' relief, leaving the handsome sum of over half a million pounds for educational purposes." Of this remarkable fact Mr. Rae says:

"When we think that there are more than one hundred and twenty counties and county-boroughs in England and Wales, the unanimity with which they denied themselves the relief a benevolent Chancellor devised for them, and spent the money instead upon the new excitement of technical education, is really surprising. No county or county-borough in England and Wales now applies the whole of the beer money, and only eleven apply any part of it, to the reduction of their local burdens."

The successful results of the use of the fund for fostering technical schools in England are very elaborately stated.

Outlook for Western Farmers.

HON. L. D. LEWELLING, governor of Kansas, in "Problems Before the Western Farmer" (*The North American Review* for January), takes a gloomy view of the agricultural situation in the West. He regards the status of the agricultural interests in Kansas as "probably similar to that of other Western States," and, on the conditions therein existing, he bases remarks thought to be generally applicable to prevailing conditions in the entire section. The farm mortgage debt of Kansas, as shown by the census of 1890, aggregates $167,145,039, and, when to this is added the real estate mortgage debt on lots, municipal, county, and school-district debts, railroad indebtedness, State bonds, and chattel mortgage indebtedness, the sum divided by the entire population gives the quotient, five hundred dollars, of indebtedness "for every man, woman, and child in the Commonwealth."

"It is said with much truth that the entire burden of debt hanging over the Western and Southern States must be paid by the agricultural class. And yet in Kansas more than ten thousand persons of this class are annually dispossessed of their homes in consequence of the foreclosure of mortgages, and the number is probably increasing rather than diminishing. Interest grows by day and by night, through the wet season and the dry, while land values decline and the price of products steadily depreciates; and the end is not yet. . . . Twenty-five to twenty-eight years ago, with one bale of cotton, a Southern farmer could buy nearly five hundred dollars, and with one sack of wheat (two bushels) a Northern farmer could buy five dollars. Now it requires seventeen bales of cotton and more than six sacks of wheat to bring these respective amounts. What is true of cotton and wheat is also true of other products of the farm. A few years ago an average horse would have been regarded as sufficient security for fifty to seventy-five dollars; but to-day it would require eight horses of the same kind to secure an equal amount. The farm which was regarded as ample security for fifteen hundred dollars is in many instances now sold for the mortgage, or perhaps less. And thus well-to-do farmers are being gradually forced into bankruptcy. Throughout the West, men who would borrow money find it impossible to offer security."

After these statements, what shall we think of the picture of content among the agricultural masses to which we were treated by Octave Thanet in the October number of *The Forum?* A condition of hopeless indebtedness verging on bankruptcy is not usually one of sweet content; and, when farmers are selling at forty cents a bushel wheat that costs fifty cents to produce, it seems almost mendacity to assert that they are contented. On the contrary, listen to this: "To comprehend the condition of the Western farmers, it must be understood that they are largely a debtor class, and they feel that in the gradual shrinkage of values they have been wronged. They also believe legislation to be responsible for the shrinkage, and look to legislation for a remedy." This is not the voice of contentment. It is a voice that is more and more making itself heard, and its complaining is a full, clear explanation of the trend of political events in Kansas and other Western States. "With even moderate returns for their products the farmers would have been satisfied; but with the low prices, each year tending lower, interest and taxes became more burdensome, and attention was called to the enormous amount of money each year forwarded to the Eastern mortgage-holder. It was argued that the total increase of wealth in the United States since the foundation of the government had not exceeded three per cent. per annum, and yet the Western farmers were compelled to pay tribute to money-lenders of six, eight, ten, and even twelve per cent. per annum, and were thus speedily drawing forward toward bankruptcy. The conditions were emphasized in Kansas by pointing to the ten thousand farm people made homeless every year by mortgage foreclosures, who, being thus deprived of their homes, were made dependent on their labor for support, and thus swelled the great army of unemployed. This, indeed, was the bond of sympathy everywhere between the farmer and laborer, and may account in some measure for the lively sympathy manifested by the farmers for striking laborers and the so-called industrial army. Each argued that he, himself, might soon become one of the homeless and unemployed. And this is one reason why partisan feeling became so intense among Populists."

Here is exposed the secret of the support given to Coxey's army on its way to Washington, and in this sympathetic feeling is shown the origin of the Farmers' Alliance and of the Populist Party, the doctrines of which were promulgated "with a sort of politico-religious enthusiasm seldom witnessed in political campaigns." The Western farmer believes "the prime cause of all his woes is the manipulation of the money system of the country by unscrupulous and mercenary interests." Whether he is right or wrong in this conclusion, he is a force to be dealt with,—a force which cannot be ignored by those whose hands are to shape the destinies of the country.

Convicts on Public Roads.

THE policy of the utilization of convict labor for the public benefit is an ancient one. Until society has learned to eliminate crime and criminals, and relieve itself from the maintenance of prisons and other penal institutions, the problem of how to punish criminals with least cost to the State will be studied with reference to the most economical way in which punishment can be united with labor without at the same time disturbing the general current of industry. Recently there has arisen strenuous opposition to the employment of convict labor in manufacturing industries, by which more or less competition is created between prison labor and free labor, and the tendency of opinion in some quarters now appears to be toward the employment of prison labor in occupations requiring labor pure and simple rather than skill.

On the other hand, there is a large number of people who regard the reform of criminals as the chief end of punishment, and who reason that, if criminals during confinement can be taught some trade or occupation which can be practised after their release, they will be less likely to fall back into crime. There is room for argument on both sides of this question, and recent labor disturbances growing out of the employment of convict labor, especially in mines, have strongly impressed the public mind with the belief that the subject demands careful reconsideration. Many able thinkers regard the good of society as the sole excuse for human punishment, and believe that, as the criminal has forfeited his social rights by misconduct, the treatment he should receive should be determined from the standpoint of public welfare, and that his individual welfare should be entirely subordinated to this. Others, looking upon crime as an effect of moral disease, defective education, etc., regard criminals rather as victims of misfortune, to be pitied rather than severely punished, and the humanity of this view is well calculated to win the support of a large class of sympathetic people.

Prof. Holmes, State geologist of North Carolina, is the author of an article in the *Manufacturers' Record* (Nov. 16) which gives the workings of the system of applying convict labor to the improvement of public highways in that State, and evidently regards this as at least a partial solution of the problem of good roads, as well as that of making criminals compenate in some measure by public service for he public injury they have committed.

"In a few of the counties the experinent has been in progress for more than a ecade; in others it has been started vithin the past year, and it now seems robable that more than a dozen additional ounties will adopt this system during the ext twelve months. So that it will be een that the system is growing in favor, nd of the counties which have already dopted it not a single one will at the resent day listen to a proposition to abolsh it.

"In a few cases this plan has been dopted by the township, and in such ases the entire management of the conict force and of the work which they do s under the control of the township board f supervisors or magistrates. When it is county measure, this control is in the ands of the commissioners. And in both ases a supervisor or superintendent of the onvict force is employed, who has charge f the details of the work, and who emloys a sufficient number of guards to preent the escape of the convicts.

"A system styled 'unique' is used in enoir county, N. C. All long-term or dangerous' convicts from this county are ent to the State penitentiary. A dozen or nore of the short-term convicts have been mployed on the roads for the past year, nd with most satisfactory results, at a ost not exceeding fifteen cents a day per onvict for food and clothes. No guards ave been employed. One superintendent r foreman has managed the squad unrmed. Each convict in the beginning as been photographed and carefully decribed, and has been notified that, if he ttempted to escape, he would sooner or ater be caught and punished, but that, if e remained at his post and worked faithully, at the end of his term he would be iven a reward. As a result of this treatnent, although these convicts have been llowed the privilege of staying with their amilies from Saturday night to Monday norning, not a man has attempted to esape, or has failed to report for duty on Ionday mornings or at any other time."

On the whole, the results of this sort of employment for convicts seem favorable, but it is pointed out as "an important fact to be kept in mind" that in all prisons there are some who cannot endure severe labor, and some who are so desperate and dangerous "that they must be allowed no shadow of a chance to escape." This brings us back to the problem of the kind of work that should be supplied to prisoners who must be held in confinement; so that road improvement is not such a complete and final solution as at first it might appear. At least the long-term, able-bodied, and dangerous criminals ought to be made to work enough to support themselves, without expense to the State, and, if their labor can be made to more than pay their keep, this excess may well be retained by the State as in the nature of a fine, and as part of their punishment.

The Labor Church.

ONE of the phases of industrial sociology destined to a place in the history of our times is the religious phase. When Dr. McGlynn expounded the doctrine that the Roman Church is emphatically the church of the poor, and that, because poverty has come upon the laboring classes, the great influence of the most powerful hierarchy in the world should be exerted on the side of the struggling and suffering masses, he indicated clearly the possible identification of the material interests of labor with the religion of the poverty-stricken masses whose cause he has wisely or unwisely espoused. The Salvation Army has been another indication of this possibility; and in the so-called "Labor Church," the first service of which was held in Manchester, England, on the afternoon of Sunday, October 4, 1891, the possibility became a fact. An account of this movement, "The Labor Church: Religion of the Labor Movement," by Mr. Trevor, is given in *The Forum* for January. Among the personal sketches of its writers for the month, that of Mr. Trevor follows:

"Mr. John Trevor, born in Liverpool, England, 1855, was educated at Wisbeach, Cambridgeshire, and afterwards became an architect. In 1877 he visited Australia and later the United States, where he spent a year at the Meadville (Pa.) Theological School. He then returned to England, and, after a year at Manchester New College, became assistant-minister to Philip Wicksteed at the little Portland-street Chapel in London. In 1890 he returned to Manchester, and with the help of friends founded the Labor Church. Mr. Trevor edits the *Labor Prophet*, and he has published two pamphlets, Theology and the Slums; and Man's Cry for God."

A considerable part of Mr. Trevor's paper is devoted to his personal evolution into a "Labor Prophet," though he has appropriated this title only for the publication he edits. Passing over this part, we come to the formulated principles or creed of the Labor Church.

"1. That the labor movement is a religious movement. 2. That the religion of the labor movement is not a class religion, but unites members of all classes in working for the abolition of commercial slavery. 3. That the religion of the labor movement is not sectarian or dogmatic, but free religion, leaving each man free to develop his own relations with the power that brought him into being. 4. That the emancipation of labor can only be realized so far as men learn both the economic and moral laws of God, and heartily endeavor to obey them. 5. That the development of personal character and the improvement of social conditions are both essential to man's emancipation from moral and social bondage."

The *Labor Prophet* is the organ of the movement, and is sold at one penny per copy. "A Labor-Church hymn-book followed, and more recently a tune-book has been issued. Labor-Church tracts have also been published, and many thousands of handbills explaining our aims and principles. In July, 1892, a Labor Church was opened at Bradford, and others soon followed. In every case the demand for a church has been entirely local and spontaneous. In July, 1893, the first conference of Labor-Church delegates was held in Manchester, a Labor-Church Union was formed, a constitution adopted, and a council appointed to carry forward the work of the movement. Fred Brocklehurst, who had formerly assisted me in the work, was appointed general secretary to the union. Mr. Brocklehurst had studied at Cambridge with a view to entering the Church of England, but, immediately upon taking his academic degree, he threw himself wholly into the Labor-Church movement.

"At the time of the conference in 1893, there were fourteen churches; there are now twenty-four. In connection with several of the churches adult classes are held, libraries have been formed, and very poor children are fed and entertained in the winter and taken into the country in the summer. The publication of the hymn book and the tune-book has enabled them to develop very hearty and characteristic singing. Solos, glees, and anthems often form part of the service. Social gatherings are frequently held on Saturday evenings in the winter. At the present moment we are going forward with the formation of Sunday schools."

Mr. Trevor thinks the Labor Church is destined to become international, basing this opinion upon the fact that it has already migrated to America and taken root in Lynn, Mass., and Providence, R. I. It presents the curious spectacle that its preachers are, so far, admittedly "politicians first and foremost." The movement is unique in some of its features, but is of a kind that may draw to it many followers. The effect of religious enthusiasm upon social upheavals has been often demonstrated in history, and many instances will readily recur to well-informed persons. This experiment of combining politics with religion may develop some curious sociological reactions before it is ended.

The Nature of Political Authority.

To Prof. R. T. Ely's article in the October number of *The Forum*, noticed i this department of our November number the strongest reply yet seen is editoriall made in a scientific periodical. In thi article Prof. Ely is charged with "the confusion of a simple matter by the introduction of what Auguste Comte would hav called 'metaphysical considerations.' Pro ly raised the following questions, which he editor of *The Popular Science Monthly* Dec.) quotes and comments upon.

“ ‘What is the source and sanction of he authority of the State?’ Is the State, e goes on to ask, ‘a mere aggregation of ndividuals, accomplishing their purpose imply by brute force? Does might make ight? If it does, then is not the question etween Anarchy and its opponents simply question of superior force? But if it oes not make right, what does make ight? Has the State an ethical nature? f the State is itself non-ethical, can the ower which it exercises have an ethical lement? But if it is devoid of an ethical lement, can it rest upon anything less han mere brute force?’ This is rather a ong string of questions, and the professor ells us that he will not attempt to answer hem; but he observes that, if the State is a ivine institution and derives its authority rom God, ‘then we have a ground of opposition to Anarchy.’ Otherwise—he evi- ently means us to infer—our ground is ery weak.”

To the question, “Is the State a mere ggregation of individuals, accomplishing heir purpose by brute force?” it is an- wered: “No, the State is an aggregate of ndividuals whose views in regard to what s a desirable constitution of society are n the main harmonious, and who have no ccasion to use brute force except upon a ertain limited number of stupid offenders gainst laws which, in their general opera- ion, make for the good of the community s a whole. ‘Does might make right?’ nswer: No, might does not make right, ut it is an excellent thing for giving effect o what the upholders of social order be- eve to be right. ‘If it does, then is not he question between Anarchy and its op- onents simply a question of superior orce?’ Answer: No, for if might makes ight (which is the hypothesis), then right as well as might is on the side of the State. ‘But if might does not make right, what does make right?’ Answer: The only way to ‘make right’ is to do right actions. Right is something that can never be more than approximately attained; but we hold that social order is right because it secures, or at least makes possible, the happiness of the great majority of human beings, and deprives none of happiness save those whose happiness involves unhappiness to others.”

If an ethical character be ascribed to the State, it is argued that this could only “find expression in the action of individuals.” As to the State being a divine institution, the answer is that it “derives its authority from God just as much as and no more than the New York Central Railway, or any other corporation, down to a village baseball club. It may be under righteous or unrighteous control; so may the railway, so may the baseball club. When it enacts dishonest and oppressive tariff laws, it is just as well not to lay too much stress upon its divine mandate. On the other hand, when it enacts an honest law for the good of all; when it faithfully carries out its obligations, national or international; when it upholds justice between man and man,—we set the seal of our moral approval on its action, but we do not ascribe any special authority to that action on the ground that ‘the State is a divine institution.’ We feel instinctively that nothing can be more divine than justice, and, when the State succeeds in being just, we simply rejoice that it has been able to approximate to our conception of the divine. The State, in fact, does not, so far as this goes, differ in any respect from the humblest individual citizen who has it in his power to do right or wrong, to place himself in harmony with or in opposition to what he feels to be the will of God.” This seems a “facer” for Prof. Ely.

INDEX TO LEADING ARTICLES.

he journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

25590. The Liability of Labor Unions for)amages—The Lucke Case. R. W. Raymond E M J–Sept. 29.) 500 w.

25618. Governor McKinley Compares the New and the Old Tariff Laws (B I S–Oct. 23.) 1500 w.

We supply copies of these articles. See introductory.

25591. Bimetallism vs. Silver Monometallism (E M J–Sept. 29.) 1500 w.

†25963. The Work of the Beer Money. John Rae (C R–Oct.) 12000 w.

26849. Convicts on the Public Roads. Professor Holmes Gives the Workings of this System in North Carolina (M R–Nov. 16.) 3000 w.

†27412. The Nature of Political Authority. Editorial (P S M–Dec.) 1200 w.

*27454. The Causes for Prevailing Low Prices—Supply and Demand a Universal Law. Albert Williams, Jr. (E Mag–Feb.) 3000 w.

*27541. Advances to Farmers.—A Practical Suggestion (B M–Dec.) 1600 w.

*27542. Mr. Shaw Lefevre on the Fall in Prices (B M–Dec.) 3000 w.

*27561. The Labor Department of the Board of Trade (Tr–Nov. 30.) 1200 w.

27562. Lord Farrer on Statistical Science (J G L–Nov. 27.) 2200 w.

†27585. Hours, Labor and Wages (I E–Nov. 3.) 1200 w.

27647.—75 cts. The Nature of Sociology. Bernard Moses (J P E–Dec.) 5000 w.

27648.—75 cts. Adequacy of the Customs Revenue System. Robert F. Hoxie (J P E–Dec.) 11300 w.

†27664. How to Multiply Small Holdings. Lord Carrington and Harold E. Moore (N C–Dec.) 5800 w.

†27665. The Cry Against Home Work. Ada Heather-Bigg (N C–Dec.) 7000 w.

27711. Currency and Its Reform (E M J–Dec. 15.) 3000 w.

*27780. Federation and Some of its Attendant Advantages (B M A–Nov.) 9000 w.

28856. Gold Exports and Currency Reform (E M J–Dec. 22.) 1200 w.

27861. A Co-operative Foundry Enterprise. Ill. J. T. Bramhall (F D–Dec.) 1100 w.

27862. The Mission of Trade Unions. Martin Fox (F D–Dec.) 1000 w.

27940.—$1. Money and Bank Credits in the United States. Henry W. Williams (An A A–Jan.) 9000 w.

27941.—$1. How to Save Bimetalism. Duc de Noailles (An A A–Jan.) 4000 w.

27942.—$1. Trusts: Abuses and Remedies. Jerome Dowd (An A A–Jan.) 2000 w.

27943.—$1. The Relation of Economics to Sociology. Simon N. Patten (An A A–Jan.) 3300 w.

*27962. Intercolonial Trade and Communication. Editorial (E–Dec. 14.) 2000 w.

*28003. Our Dwindling Trade with the East. Jeremiah Head, with Editorial (I C T–Dec. 14.) 3800 w.

28050. Symposium in the Currency. I. Why Government Notes Are a Bad Currency. Van Buren Denslow. II. Reply: Why the Creation of Money Is the Primary and Paramount Duty of Government. Henry Carey Baird (S Ec–Jan.) 4200 w.

*28051. An Argument for the Single Tax. Isaac Feinberg (A M C–Jan.) 4000 w.

*28052. Gold and Silver Both. H. A. Scomp (A M C–Jan.) 4000 w.

*28053. What Ails Unskilled Labor in America? P. Vedel (A M C–Jan.) 3700 w.

*28054. Some of the Dangers of Free Coinage. Arthur B. Dale (A M C–Jan.) 2000 w.

*28055. An International Paper Currency. John F. Hume (A M C–Jan.) 2900 w.

28080. Better Prevent than Settle Strikes. Editorial (A M & I W–Dec. 28.) 700 w.

†28084. The Coming Industrial Order. James G. Clark (A–Jan.) 5200 w.

†28085. The Sweating System in Philadelphia. Frank M. Goodchild (A–Jan.) 2200 w.

†28087. Our Trade with China. Worthington C. Ford (N A R–Jan.) 3600 w.

*28091. The Industrial Christian Alliance of New York. Arthur W. Milbury (R of R–Jan.) 4500 w.

*28104. The End of a Trade Union.—The National Amalgamated Sailors' and Firemen's Union. Editorial (Eng L–Dec. 21.) 1600 w.

†28159. Problems before the Western Farmer. L. D. Lewelling (N A R–Jan.) 1800 w.

28171. The Insurrection of June and July, 1894. (Extract.) Joseph Nimmo, Jr. (R R–Dec. 29.) 2500 w.

*28222. The Humiliating Report of the Strike Commission. H. P. Robinson (F–Jan.) 3800 w.

*28223. Grave Danger in Our Presidential Election System. James Schouler (F–Jan.) 2000 w.

*28224. Is the Existing Income Tax Unconstitutional? David A. Wells (F–Jan.) 1700 w.

*28225. The Anatomy of a Tenement Street. Alvan F. Sanborn (F–Jan.) 8000 w.

*28226. The Crux of the Money Controversy: Has Gold Risen? Louis A. Garnett (F–Jan.) 2800 w.

*28227. The Labor Church: Religion of the Labor Movement. J. Trevor (F–Jan.) 2200 w.

*28228. A New Aid to Popular Education: Free Travelling Libraries. William R. Eastman (F–Jan.) 2500 w.

*28229. The Increasing Cost of Collegiate Education. C. F. Thwing (F–Jan.) 2500 w.

*28230. The Financial Year and the Outlook. Anon (F–Jan) 2000 w.

28237. Labor as an Element in Southern Manufactures. William M. Stewart (T–Jan. 1.) 2000 w.

28238. Comparative Study of Southern Labor. J. B. Killebrew (T–Jan. 1.) 2500 w.

28239. The Importance of the Nicaragua Canal to the South. Ill. Warner Miller (T–Jan. 1.) 1800 w.

28241. The Industrial Future of the South. Clark Howell (T–Jan. 1.) 800 w.

28307. The Nicaragua Canal. S. Waterhouse (A S–Jan. 5.) 4000 w.

MARINE ENGINEERING

Administration of the British Navy.

THE placing of men in positions for
hich they are unfit is something which
equently happens in the administration
f public affairs. Social and political in-
uence overshadow merit, and the "Tite
arnacles" get their innings with accom-
animents of fat salaries and perquisites,
hile sterling worth and real ability go into
etirement, or, if in office, are repressed in
terests of political rings. The people of
e United States have seen so much mal-
dministration that sometimes, in discour-
gement, they think we must be worse than
ther nations, and wonder why it is so.

Some of the comfort which is said to be
fforded to the miserable by the knowledge
at others suffer also may be derived from
editorial in *Engineering* (London, Dec.
. Discussing the paper on "The Ma-
inery of Warships' read before the In-
titution of Civil Engineers (Nov. 20), it
nds it a mass of "dry bones," affording
nly unsatisfactory pickings; and among
e reasons assigned for such a paper from
able an engineer as Mr. Durston is found
e crumb of comfort above mentioned.

"The paper itself was confessedly incom-
lete, but it was as complete as our politi-
al organization allowed us to expect it to
e. Every one knows that Mr. Durston
ould, if he were permitted, write a really
ood and instructive paper on 'The Ma-
hinery of Warships,' instead of putting to-
ether a record of bare dimensions and
ald details of performance. We know that
e engineer-in-chief, and those associated
ith him, have very decided views on some
oints connected with the practice of ma-
hinery design; and, indeed, they would be
ltogether unworthy of their positions were
not so. Why, then, is the Institution
erved with a paper so inadequate to the
ecasion? The answer is not far to seek.
he engineer-in-chief is an official in the
epartment of the controller of the navy,
nd is entirely subordinate to the control-
r. That is a matter of routine. The controller of the navy is an executive officer of high attainments, a rear-admiral whose professional instincts and training do not put him in sympathy with engineers. The traditions of his caste all tend toward exclusiveness and secrecy, and the traditions of the department into which he has been brought support this attitude. But, even if the controller of the navy were a man of the widest views, he is not master of his own actions. He holds office for a short period,—so short that he has not time to learn his duties before he has to go. The consequence is that he is very much in the hands of the clerks,—a class without the high, even if unenlightened, sense of duty towards the service which is the main spring of the naval officer's conduct. Neither have they the scientific interest which animates the professional officials. There is, however, another check on our ideal liberal-minded controller,—the political element, which is paramount. No ordinarily intelligent newspaper-reader need be told how little account an engineering department of the navy is in the eyes of the average parliamentarian. The whole mystery of party politics is to lie low whilst in office, and trip your enemy's heels when out."

This state of things is regarded as cause for apprehension. What may be expected to happen in the case of a serious naval war is pointed out. "The highly trained professional officials at Whitehall are unable to do themselves justice before the public, or to expose their work to the healthy criticism and discussion which would so much strengthen their hands, increase their knowledge, and give them a wider interest in their labors. No class suffers more from the absurd secrecy of the department than the constructors and engineers of the admiralty staff. Some day, perhaps, we will have a serious naval war. Then the country will learn this ill-assorted triumvirate of government clerk, parliamentarian, and executive officer is not the right instrument with which to mould and direct a great engineering organization. We shall learn it at the expense of many valuable lives and the loss of much inestimable treasure,—probably at the cost of a serious military disaster."

It is charged that the treatment of contractors by the admiralty has recently been very bad, and that makers of navy engines have thereby become thoroughly dispirited. One firm is cited as having lost ten thousand pounds on a contract for their ships; others have suffered in a similar manner, and their losses are referable to waste and mismanagement on the part of the admiralty.

The Colomes Leak-Arrester for Ships.

In the spring of 1894 tests of the Colomès leak-arrester were made before a board appointed by the United States navy department, and in the presence of several naval officers, Mr. Lewis Nixon, a well-known naval constructor, and Capt. Constance, naval attaché of the British Legation in Washington. The tests were made with tanks, in the sides of which holes, analogous to those made by rocks or projectiles in the bottoms and sides of ships, were formed, the tanks being kept filled to a certain height by pumps during the performance of the experiments, which consisted in stopping the holes in the tanks on the outside in the same manner as they would be stopped at sea on the inside of the vessel.

The vital features of the system consist in the material employed, the simple mechanical means for making the required application of this substance to the leak, and the also extremely simple manipulation which, performed in from thirty seconds to three minutes, either completely stops the leak, or, in the few cases where the irregularity of the opening prevents absolute stoppage, so far obstructs inflow as to obviate any danger therefrom.

The material relied upon for stopping leaks is cellulose, a substance that greatly increases in bulk by the absorption of water. Figures 1 and 2 respectively illustrate a hole to be stopped and the apparatus applied to the same opening, and stopping it. *The Iron Age* (Jan. 3) gives a description of the apparatus and an account of the tests above mentioned. It is stated that the system, after trial, has been adopted by the French government.

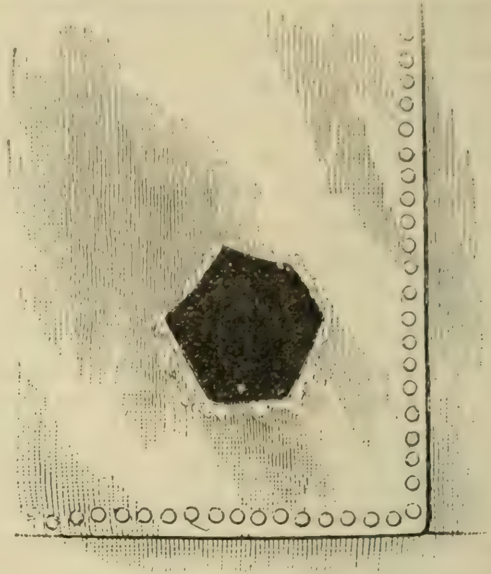


FIG. 1.—SHAPE OF HOLE.

"The apparatus for applying the cellulose to the hole is extremely simple. It is composed of a steel rod, threaded on a part of its length, at the end of which is pivoted an iron piece, which, when at right angles to the rod, has the appearance of a pickaxe, one of the arms of this cross-piece being heavier than the other. This cross-piece has fixed to it an oval piece of flat iron covered with thick felt. A small conical bag, filled with cellulose, and having a hole through its center, can be slid onto the rod. Back of this bag is applied a large washer, which is held in place against the

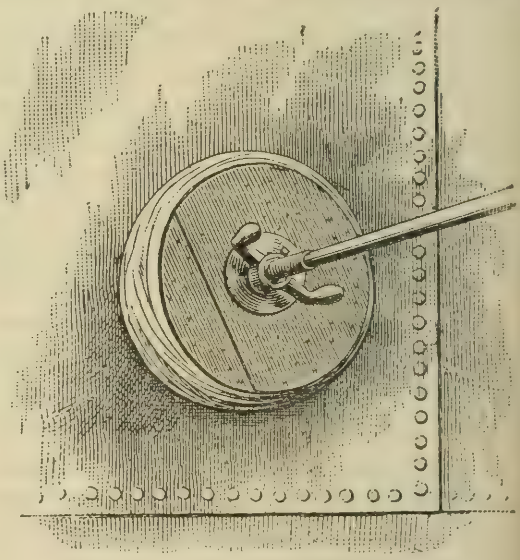


FIG. 2.—HOLE STOPPED.

bag, as shown in Figure 2, by a nut which is pushed down the rod to the threaded part, where it engages the screw. When a leak has been located, any man can seize a leak stopper corresponding approximately in size to the width of the hole. Then, holding it with the lighter end of the pick toward him, so that the pick and oval plate lie alongside the rod, he can introduce it into the hole. He can avoid the rush of the water by standing to one side. As soon as the pick has passed through the plating, the heavier end descends, and the pick places itself across the hole, while the pressure of the outside water forces it against the side of the vessel and throws the pick arm across the opening; so, resting on the plating around the hole, it affords a point of support, while the felt-covered plate reduces the leak very much and makes easier the next operation, which consists in slipping the bag of cellulose, washer, and nut over the rod, screwing down the nut till the bag of cellulose is compressed against the hole. The cellulose bag fills up all parts of the hole, no matter how irregular, as the great value of the cellulose consists in its absorbing water and greatly increasing its volume. This elastic mass makes a tightly-applied mat over the hole, which cannot be accidentally disturbed or displaced. Should the hole not be more than ten inches wide and several feet long, a number of leak-stoppers can be used side by side, so as to gradually fill the hole. For holes of much larger area Mr. Colomès proposes to use a cellulose mat to be applied from the outside of the vessel. This mat resembles an ordinary mattress filled with obturating cellulose, and is made in several sizes. The side of the mat away from the side next to the ship is covered with water-proof cloth, in order to prevent too much water from filtering through the cellulose. On the sides and at the corners rings are fixed, intended to receive guiding ropes. Such ropes should always be kept in readiness on the upper deck, bent and with the slack so arranged that they will fall under the vessel so as to hang from gunwale to gunwale. These ropes are to receive the mats as soon as a leak is discovered and located. The soft, pliant nature of the cellulose lining of the mat enables the pressure of the water to force it into all parts of the opening, so that every crack is filled and the inflow automatically stopped." In the experimental tests referred to, against a head of twelve feet, a 2½ inch-hole was stopped in thirty seconds, a 10-inch hole in three minutes, a 21-inch hole in thirty-seven seconds, and a 21-inch hole in one minute and forty seconds.

Water-Tube Boilers for Marine Use.

In a paper read before the Wissenschaften Varien der k. und k. Kriegsmarine, which has been translated and is now appearing serially in *The American Engineer and Railroad Journal*, the first number of the series contains a comprehensive classification of water-tube boilers, and gives promise of an attempt to treat the subject thoroughly. Four groups of types are taken as including all the water-tube boilers that have yet appeared. While, in respect of types, this classification may be accepted without demur, the boilers named as included in the different classes do not comprise all that have gone into extensive use, some of the more important—for instance, the Sterling and the Heine—not being mentioned. Possibly the placing of the Babcock and Wilcox boiler in the class of those with bent tubes is an inadvertence. The classification follows:

'(a) Water-tube boilers with straight and level tubes. This group comprises the Perkins, Belleville, Palmer, and Herreshoff boilers. (b) Water-tube boilers with straight and inclined tubes. These are the Root, Watt, Belleville, Yarrow, Oriolle, Lagrafel, d'Allest, Sampson, Durr, and Niclausse boilers. (c) Water-tube boilers with bent tubes. Of such are the first Belleville boilers, the Rowan, Ward, Du Temple, Normand, Thornycroft, Yarrow, Babcock & Wilcox, Wilson, and Gleming & Furguson boilers. (d) Water-tube boilers with spiral tubes. These include the Herreshoff, Hohenstein, Bellís, and White boilers."

The circulation in water-tube boilers, which is one of the most important principles in their action, is illustrated by Figures 1, 2, and 3. "As the water contained in the tubes is heated, it rises into the space above, causing a circulation in the boiler. While the warm and specifically lighter water rises into the water space above, an equal amount of cooler and specifically heavier water descends.

"Such a circulation is shown in Figure 1, where the heated water rises at *B*, while the cooler water flows back through *C*. The rapidity of the circulation can be increased by introducing the feed-water at *D*. The case often occurs that the water in one part is lighter, because it is a mixture of steam and water, as represented by Figure 2, and the hydrostatic law seems at fault, for it is independent of the hydrostatic pressure on the cross-section: so the circulation of the water will be maintained by the generation and the movement of the steam.

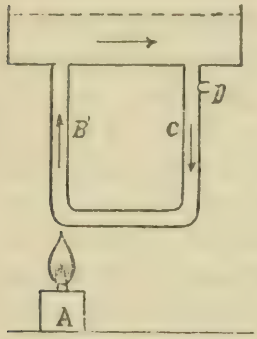


FIG. 1.

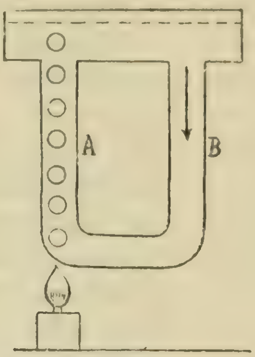


FIG 2.

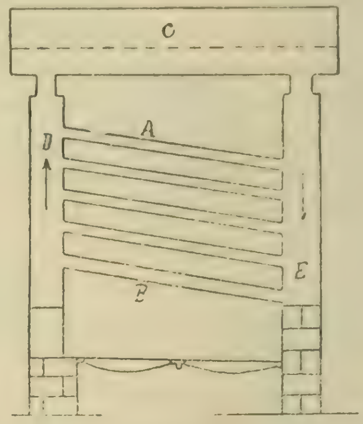


FIG. 3.

"A strong and regular circulation of the water is an essential feature for the proper action of water-tube boilers. It protects the tubes which are subjected to high temperatures from burning; it equalizes the temperature and the expansion of the whole boiler structure; and the result is that the generation of steam is raised to the highest possible point. The circulation of the water ought not to be injured through the choice of the sectional area of the tubes. The higher the temperature and the greater the corresponding length of the tubes, just so much the larger must the cross-section of the same be made; otherwise the tube, on account of an insufficient circulation of water, will only deliver a stream of steam.

"The form of boiler given in Figure 3 shows that, if the sectional area of the tubes at *A* is sufficient for the circulation of the water, then that at *B*, where a higher temperature exists, will be insufficient. The result is that the tubes are overheated, and this has actually occurred in many miscalculated water-tube boilers. On the other hand, it is a further requirement from the standpoint of safety that the sectional area of the tube should not exceed a certain amount, in order that the average tube can be run to advantage. It is upon these grounds that the diameters of water tubes for the different types of boilers used on vessels of war vary between the wide limits of 1 in. and 4 in., while the boilers for vessels engaged in commerce are usually fitted with tubes of the larger sizes."

The extent to which water-tube boilers have gone into use for marine purposes is also indicated. In 1879 the French despatch-boat, Le Voltigeur, was fitted with the Belleville boilers, and up to the present time the French admiralty has applied the boiler "to vessels of all sizes and kinds." Eighteen French ships, varying from 400 to 14,000 I. H. P., seven Russian vessels, varying from 200 to 15,000 I. H. P., and three English ships varying from 3,500 to 25,000 I. H. P., are named as being furnished with power by the Belleville boiler, these all belonging to the navies of the countries mentioned. A considerable number of vessels in the merchant marine are also enumerated as using Lagrafel, Babcock & Wilcox, and other kinds of water-tube boilers.

Sanitation of Ships.

At the recent congress of the Sanitary Institute in Liverpool, Sir William Forwood made some remarks on this subject which the *Scientific American Supplement* (Dec. 8) has printed. The council of the sanitary congress decided that special attention should be directed to the consideration of sanitation in ships, and the address was for the purpose of bringing the subject before the section devoted to the subject, over which section Sir William Forwood presided. He asserted that a discussion of the past and present status of sanitation in ships would be welcome to Liverpool ship-owners, who had "always been in the forefront in the adoption of every improvement likely to promote the health and comfort of the people in their employ."

The three great essentials in sanitation—good air, good drainage, and pure water—can easily be obtained at sea, and on this account, perhaps, it might be thought that a discussion of the sanitation of ships is unnecessary. But the condition of ships, especially in the forecastle, was, not many years ago, "a disgrace to our civilization." Much improvement has been made, but there is yet room for reform. What has already been accomplished is very praiseworthy and encouraging, as is shown by a contrast of past with present conditions.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*27463. The Great Steamboats of the Hudson River.—The Evolution from the Earliest Types. Ill. Samuel Ward Stanton (E Mag-Feb.) 3000 w.

*27527. The Commercial Speed of Steamers. (Abstract.) J. Denholm Young (S L-Dec.) 2000 w.

*27528. Consideration on the Battleship in Action. William Laird Clowes (S L-Dec.) 2400 w.

*27553. Engineering in the United States Navy. Editorial (E-Nov. 30.) 1700 w.

*27560. A Glance at the German Ports (Tr-Nov. 30) 2200 w.

27632. The Future of Our Shipping.—Discriminating Duties the Best Remedy. Richard P. Joy (Sea-Dec. 13.) 1000 w.

*27672. The Machinery of Warships. Editorial (E-Dec. 7.) 2400 w.

*27673. Electricity on Shipboard. Editorial (E-Dec. 7.) 900 w.

*27945. Proposed Government Shipbuilding Yard at Lisbon (B T J-Dec.) 1800 w.

*27966. The Chilian Cruiser Blanco Encalada. Ill. (Eng L-Dec. 14.) 7400 w.

*27970. The Machinery of War Ships. Edtorial (Eng L-Dec. 14.) 2400 w.

*28004. The Commerce and Shipping of the Great Lakes (Tr-Dec. 14.) 2000 w.

28026. The Cramp Ship Yard. Ill (Sc A-Dec. 29.) 1500 w.

†28088. Shall We Have Free Ships? Edward Kemble (N A R-Jan.) 4000 w.

*28099. H. M. S. "Magnificent." Editorial (E-Dec. 21.) 3000 w.

28156. The Calomès Leak Arrester for Ships. Ill. (Ir Age-Jan. 3.) :000 w.

28283. Repairing a Broken Valve Chest on the Concord. Ill. Harold P. Norton (Eng-Jan. 5.) 900 w.

28296. Sanitation of Ships. (Extract.) William Forwood (Sc A S-Dec. 8.) 900 w.

*28319. Triple Screws. Editorial (E-Dec. 28.) 2500 w.

*28322. The Luminous Power of Lighthouse Apparatus. O. Bourdelles (E-Dec. 28.) 4400 w.

*28349. The Port of Falmouth. Ill. (Tr-Dec. 28.) 1500 w.

28359. Launching of a Great Steamship.—The Most Delicate and Responsible Part of the Ship Builder's Work. Ill. (I Age-Jan.) 1100 w.

Serials.

16636. Marine Engine Design (M W-Began Oct. 6, 1893—18 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E-Began April 14—23 parts to date—45 cts. each).

26091. Some Points in Modern Marine Engine Practice (I & I-Began Oct. 12—12 parts to date—30 cts. each).

27378. Water-Tube Boilers and Their Application to War Vessels. J. Nastoupil (A E R J-Began Dec.—2 parts to date—30 cts. each).

27675. Experiments on the Strength of Cylindrical Shells. Ill. J. C. Spence (E-Began Dec. 7—Ended Dec. 14—2 parts—30 cts. each).

27701. Cellulose, and Its Application to War Ships. Em. Cheneau (I & I-Began Dec. 7—2 parts to date—30 cts. each).

28356. Navigable Diving Vessels. Sydney H. Hollands (P Eng-Began Dec. 28—1 part to date—30 cts).

MECHANICAL ENGINEERING

Selecting a Steam-Engine.

UNDER the supposition that a man has decided that a steam-engine is the kind of motor needed for his service, he is at once confronted with the question, far more formidable to a layman, of selecting from the numerous engines on the market the particular one he will purchase. Differences in price, fuel economy, size, speed, ease of management, reliability in action (which includes small outlay for repair and immunity from losses due to stoppages), and other considerations will all in turn have their influence in the selection. For each engine inspected, the would-be seller will claim the maximum number of good points and the minimum of weak ones, if he confesses to any weaknesses whatever, which he will not be likely to do except under the impression that he is dealing with an expert who will see for himself all that is not frankly admitted.

Mr. Frank Gleason, in *American Machinist* (Dec. 20), gives some excellent advice to this class of purchasers, and paints in vivid tints the sort of figure they cut when attempting to do what only a disinterested expert should be employed to do.

"The average buyer of a steam-engine is a man who knows nothing about it, but thinks he knows enough to manage his own case,—just as people do in law sometimes. The result is that he finds himself confronted with all sorts and conditions of engines; and how is he to decide? No steam-engine peddler ever acknowledged that the engine he sold had weak points, from whatever standpoint it was viewed, or that it was not best wherever it was placed. The fact is that a steam-engine, like a Kentucky mule, for example, must be chosen for what you want of it, and how it is to be handled."

That an engine shall be capable of working a long time without interruption from breakdowns, or disabilities that cannot be classed as breakdowns, such as hot journals or slides, grunting cylinders, pounding on centers, and the other ills which (some) steam-engines are heir to, is considered the prime requirement. "Human nature is said to be perverse, and to the man who finds his engine breaking down, just as the hurry is on, it will always seem as if perverseness extends to inanimate things,—to wit, steam-engines. There may have been instances of steam-engines breaking down when there is no hurry over anything about the mill or factory; but, if so, there are no authentic records of such breakdowns. Sometimes an enforced stoppage in case of a breakdown, the repairing of which may cost but a trifle, will result in a very material loss, as in inability to fill orders, flooding of mines, and in various ways; in fact, a breakdown of the prime mover seldom occurs without considerable loss outside the breakdown itself, this loss depending upon the magnitude of the works and other circumstances. In one instance, strangely enough, it resulted in the loss of the building, the only fire-pump—a condition that modern practice would not tolerate—being arranged to be quickly attached to the engine, and ample for the emergency if the engine could have been started."

Modern steam-engine designs are greatly in advance of what they were a few years ago, and perhaps this adds force to the advice that laymen should employ experts to select the motor required for a particular use; and, in some cases, an engine with the old Meyer cut-off would be preferable to one of a more refined type. Such would be the case where cost of fuel is small and the higher grade of skilled attendance expensive to procure.

How Shall We Gage Wire and Sheets?

THE vigorous and timely protest made by Mr. Oberlin Smith in *Iron Age* (Nov. 29) against the new United States standard wire gage, and the humorous, yet caustic, style in which he points out its absurdities, will meet with a response throughout engineering circles not very flattering to the authors and promoters of the law that has loaded such a mass of inconsistencies and perplexities upon the top of those already attending the use of previously existing gages. If the inch be taken as the unit of measure, the ease and accuracy with which one or more ten-thousandths of this unit can now be measured at once suggest the simplest possible scale of sizes for wire and sheets, with a range sufficient to cover all mechanical necessities. This is substantially the gage originated by Sir Joseph Whitworth, in which, Mr. Smith says, "may be seen the first glimmer of common sense yet appearing, as recorded by history, in the industry of gage-inventing." The following requirements are laid down as "the attributes of a good gage"; and it is shown that the new standard "ignores many of them."

"1. The popularity and universality which are necessary to secure definiteness of measurement in the commercial world. 2. Suggestiveness, preferably by making its unit of measurement in harmony with some other well-known unit,—as, for instance, the English inch, or convenient fractions thereof. 3. A logically progressive scale, with the smaller numbers for the smaller sizes, rather than a retrogressive one. 4. Uniformity of names or numbers,—as, for instance, from unity upward,—rather than mixing in a number of ciphers having no meaning in themselves. 5. A uniform or uniformly increasing increment in each successive size. 6. Adaptability to the convenient measurement of any substance, rather than with a limitation to a particular metal or a particular form thereof. 7. Simple and decimal fractions, rather than complicated vulgar fractions, when translated into the inch or other well-known units. 8. Capacity for additional sizes, either smaller or larger than the original ones or interpolated between the same, as requirements at first unthought of may afterward occur."

The new wire gage is criticised both from scientific and practical standpoints. Scientifically viewed, it has no rational basis, and, practically scrutinized, it is about as unhandy a scheme as ever was devised by human ingenuity. The perusal of Mr. Smith's paper will afford most people both amusement and instruction. It occupies over twelve columns, and treats the subject almost exhaustively.

Prof. Langley's Flying Machine.

The experiments of Prof. Langley of the Smithsonian Institution, though on a much smaller and less expensive scale than those of Mr. Maxim, in England, are interesting. They have supplied further demonstration that the principle involved in the use of æro-planes underlies the solution of the problem of mechanical flight. Under the title "Sailing Through the Air," the *Boston Journal of Commerce* (Dec. 22) gives an account of the latest success of this experimenter. This outcome has, as usual, been preceded by some failures. Nature is very inexorable in the enforcement of her laws, but exceedingly reticent of hints to mortals who may be unconsciously violating them. She has no favorites. Those who most wish to obey are punished just as severely for their failure to do so as those who wilfully transgress. Her method of teaching is through such penalties. If a mechanical constructor is heavily fined, in the form of lost time, effort, and money, for producing an inoperative device, he knows, in general, that he has been working in opposition to natural laws, but he is not further informed by the penalty. He must find out for himself how he has transgressed, and be careful not to repeat the offence. In this way, through the ages, man has learned something. The principles of flight have been particularly elusive, and many disappointments have been suffered by those who have attempted their discovery. At last, however, the right way has been indicated, and the future alone can show just how far it can be pursued with available mechanical resources.

Prof. Langley's new flying machine is twelve feet long and eight feet wide over all. "There are four wings, and the caudal pair—if they may be so termed—are little more than half the size of those attached to the body. But for the fact that the two pairs are separated by an interval of several feet, the nerveless creature might be described as a monstrous butterfly. The fine white cloth of which the wings are in part made is stretched over a light framework of numerous closely-set veins or ribs, adding to the likeness. The aluminum body is very light, weighing only about two pounds. It is nearly four feet long and the width is almost half the length, giving it a decidedly chunky appearance. In transverse action it would approximate a circle. At each end it terminates in a blunt point, the prow more obtuse than the stern, to which is attached the long and simple support for the caudal wings and the vertical rudder, the latter being very much like the rudder of a ship. Its function is to effect lateral changes of direction, the caudal wings serving to determine the vessel's course in vertical planes.

"To maintain the large wings of the inclination necessary for suspension in mid-air, or for increase of elevation, the caudal pair must be given a reverse inclination. The greater the speed, the more nearly may the two pairs constitute part of the same plane, and for this reason, the greater the speed, the smaller part of the energy will be consumed in the maintenance of an elevated position. Thus the possibilities of speed for the perfected aero-plane would seem to be without limit, —at least, the limit would be too remote for practical consideration. The propelling power is steam. It is applied through the agency of a little copper boiler and engine within the aluminum body, giving motion to a pair of wooden screws placed at the posterior end of the body. The little engine is marvelously light and powerful for a mechanism so reduced in size. The propeller-blades are hardly thicker than paper. They are about a foot long, one piece to each, and hum like a hive of bees."

Of course, this machine is only a scientific and mechanical toy; but it flies. This is quite enough for a beginning, and doubtless an era of experiments with this class of flying machine has been ushered in. With the history of artificial flight, if anything practical in this way ever result, the names of Maxim and Langley will be permanently identified, and it will, perhaps, be difficult to estimate which of these experimenters has contributed most to the advancement of the art.

Chimneys and Drafts.

ADVANCE sheets of a new chapter which is to appear in the fourth edition of *Helios*, an excellent publication issued by the Heine Safety Boiler Company, St. Louis, Mo., have been forwarded to us. In this chapter the subject of Chimneys and Drafts is treated with reference to the supply of air needed to effect the perfect combustion of a given weight of fuel, which is, of course, the only point of scientific approach, since the function of a chimney is alone to supply the air needed for combustion.

The first thing to be determined in the consideration of the capacity of a proposed chimney is the power required to be obtained from the fuel consumed. Next, the knowledge of the character and value of the fuel to be used will permit the determination of the weight required for a given time, and the computation of the weight of air needed to obtain practically complete combustion. Next, the dimensions of a chimney that will supply to the fuel the amount of air needed may be intelligently considered, and well-established formulæ may be employed for such computation by substituting therein values derived from the preceding investigations.

"What we call draft is simply the heavier (because colder) outside air to supply the place of the lighter (because heated) gases which rise from the furnace to escape up through the chimney. We cause it artificially in a furnace, just as wind is caused by the heat of the sun in nature. The difference in weight of the column of hot gas in the chimney and that of a column of the outside air of the same height is the force which causes the draft."

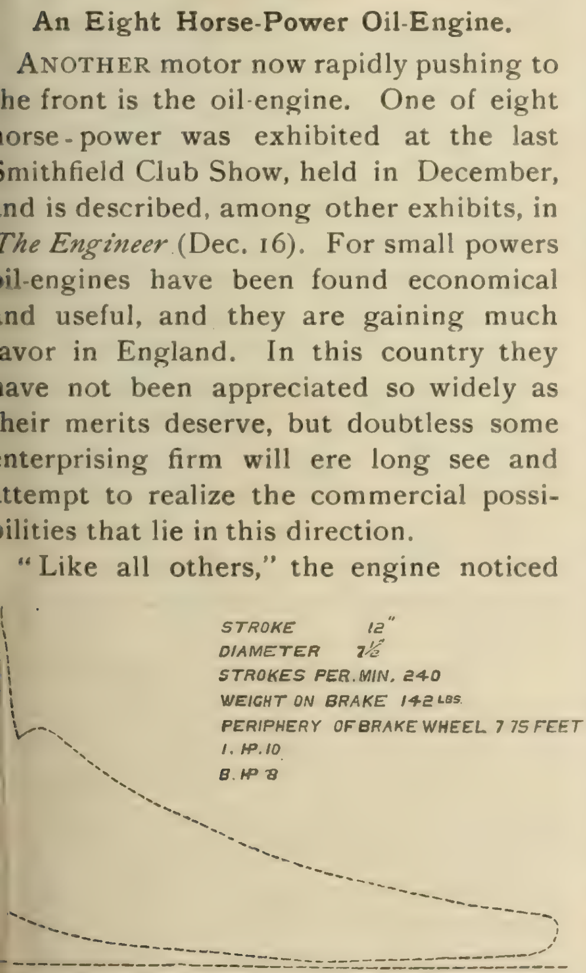
But the difference in weight of the two columns depends partly on the different temperatures, and partly on the different specific gravities of the two columns at any given temperature. Their specific gravities varying with the temperatures, ormulæ for determining these are needed, r tables by which they can be readily deermined. An important feature of the reatment of the subject in the chapter nder review, which has been prepared by Col. Edward D. Meier, C. E., M. E., presilent of the company above named, is the abular form in which most of the needed lata for computation are supplied. There re seven of these tables, each in handy orm for reference, and with these and the imple formulæ any of the practical probems relating to chimneys may be quickly nd easily resolved.

Not only may such problems be resolved, ut a clear understanding of the principles nvolved may be gained from the text, so hat a very complete scientific, as well as ractical, essay upon chimney construction as been supplied to the book by the addiion of this chapter.

An Eight Horse-Power Oil-Engine.

ANOTHER motor now rapidly pushing to he front is the oil-engine. One of eight orse-power was exhibited at the last Smithfield Club Show, held in December, nd is described, among other exhibits, in *The Engineer* (Dec. 16). For small powers il-engines have been found economical nd useful, and they are gaining much avor in England. In this country they ave not been appreciated so widely as heir merits deserve, but doubtless some nterprising firm will ere long see and ttempt to realize the commercial possiilities that lie in this direction.

"Like all others," the engine noticed works on what is known as the Otto-ycle. It is of the type which receives and onverts the oil into gaseous vapor in a vaporizer separately heated by an oil-lamp with forced air combustion; and in which ignition is effected by an ignition tube, heated by an oil-lamp with forced air combustion."



INDICATOR DIAGRAM—. OIL ENGINE

Surprisingly good indicator diagrams were taken. A sample one is herewith reproduced. The maximum pressure indicated is two hundred and fifty-three pounds, and eight horse-power is delivered to the brake, as against ten horse-power indicated; frictional losses between piston and brake are, therefore, only twenty per cent. of the indicated power,—a very good result. Many steam motors of equal capacity would do no better, if as well.

A Cheap Planimeter.

THE planimeter and the mechanical integrator have assumed such importance among the instruments of modern engineering that probably they would be much more widely used could they be afforded at a more moderate price. Carrying out an idea suggested in *La Nature*, Mr. Fred. B. Howell has presented in *American Machinist* (Jan. 10) a cheap form of this instrument devised by him, which is illustrated in the cuts herewith reproduced.

Premising that the center of gravity of any figure can be approximately found by cutting the shape in cardboard, and thrusting a fine needle through it till a point is found where it remains indifferently in any position in a vertical plane, Mr. Howell then gives a description, in which "the method of use and construction of the instrument" are given, without going into a mathematical discussion which involves the use of the calculus. Referring to Fig. 1, which illustrates the form given in *La Nature*, "it will be found, by taking a piece of wire $\frac{8}{16}$ inch in diameter and 14 inches long, and turning down 2 inches of each end, one of which is made a blunt point of tangency—of the knife edge and the plane upon which it moves—and the tracing point will be 10 inches.

"As in Fig. 2, I made the instrument by adding two attachments to Alteneder's trammel heads, substituting for the knife head a wheel with a knife edge mounted on pivot centers, so that it could roll over the surface with as little friction as possible.

"First find as nearly as convenient the center of gravity of the figure, the area of which is required, place the *pointer* on such point, press the *wheel* or *knife edge* into the paper to mark the starting point, and with the pointer trace in a straight line to the boundary line of the figure, around the figure, and then back to the center of gravity by the first drawn straight radiating line. Press the wheel—which has followed its own path—into the paper to mark the end of its travel, and the distance between the two depressions on the paper, multiplied by the distance from the tracing point to the point of tangency between the wheel and the plane upon which it rolls, is the area required.

Fig. 1

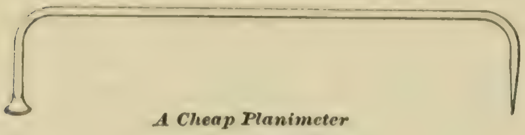
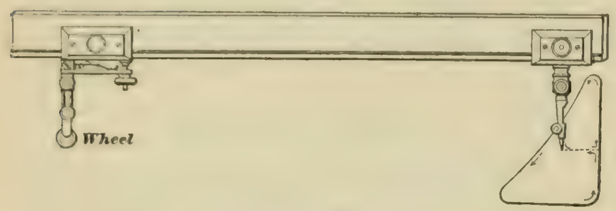


Fig. 2



A Cheap Planimeter.

"I have given the distance between wheel and pointer as 10 inches. Multiplication is performed by moving the decimal point one place to the right. . . . On figures that are more than 4 inches in any one dimension, or having more than 16 square inches, it is best that the figure be divided and the area found of the several parts."

Danger of Spring-Balance Safety-Valves.

A CASE of a boiler explosion at Dudley, England, was recently brought to the attention of the Board of Trade, which seems to have inspired in *The Practical Engineer* (Dec. 7) an editorial protest against the use of spring-balance safety-valves. The assertion is made that the use of this kind of safety-valve "has been productive of more explosions from excessive pressure than all other causes combined." While we are hardly prepared to admit the accuracy of this statement, there is no doubt that this sort of safety-valve may, and often does, become a source of danger. This kind of valve is that whereon a spring is substituted for a weight at the end of a lever, and the nature of a danger that may result in disaster is well illustrated by a brief account of the explosion referred to.

"The boiler, it appears, was employed to do miscellaneous work, amongst which was the driving of a circular saw. The attendant of this machine, being of opinion that the engine was short of steam pressure, employed the natural method which presented itself to him of remedying the defect, and screwed down the thumb-nut of the spring-balance safety-valve with which the boiler was fitted until the pointer reached the bottom of the slot. In doing this, he appears to have been under the impression that he had simply increased the load to fifty pounds, that being the figure marked on the side of the slot at this point. As a matter of fact, however, the valve was screwed down hard and fast, the pressure was bottled up, and some little time afterwards the boiler burst with disastrous effects, the whole structure being blown to fragments, which were scattered over the surrounding neighborhood to a considerable distance, while one man was killed and four others injured."

Now, this explosion was primarily due to faulty construction. A spring, so long as it is free to act, is the mechanical equivalent of a weight, except that, when stretched through a given distance, its force increases more or less, according to its length ; but in the case cited the spring was not free to act at the indicated pressure at which the valve was set. A seconc cause was the ignorance of the attendant who appears not to have had enough sens to see the condition of the valve, or enoug knowledge to perceive that the conditio as one of danger. Such a valve should ever be so made that the lever can move up gainst any obstruction before the valve lly opens, and the spring should be of ich length as not to vary in tension very uch between the full-open and full-shut ositions of the valve. If "ignorant and eckless men" are to be placed in charge f boilers, it must be admitted that a pring-balance safety-valve is a thing with hich the meddling of such men is very ndesirable, and which to some extent inreases the already existing danger of lacing ignorance and recklessness in a osition requiring the opposite qualities; ut the valve itself, properly constructed, s not dangerous, and ought not to be so tigmatized. Any form of safety-valve, exept a lock-valve, is liable to such interfernce; but the tampering of intelligence nd prudence is not a cause for much larm.

A 320 Horse-Power Gas-Engine.

If anyone has supposed the gas-engine s not liable to become a powerful rival of he stationary steam-engine, a description f a 320 horse-power Simplex motor, as nstalled in a flour mill at Pantin, France, vill probably rectify such an opinion. *The Engineer* (Nov. 30), in which the machine s illustrated and described, regards it as n illustration of "the certainty with which he steam-engine is being replaced for mill vork, though slowly, by the more economical gas-engine"; and it adds that M. M. de la Marc, of Debouteville, France, as, also, Matter & Co., of Rouen, builders of the kind of engine under consideration, "believe that they now see their way to the construction of five-hundred horse-power gas-engines."

The gas for the machine is made in Buire-Lencauchez two-part gas producers, the two parts being coupled so that either can be used independently in cleaning and firing.

In a series of tests the following results were obtained. The diagrams taken from time to time gave a maximum of 280 horse-power, corresponding, it is stated, by reference to other experience, to 220 brake horse-power. The gross consumption of coal per indicated horse-power—no deduction being made for cinders or ash—was 0.788 pounds per French horse-power and 0.803 pounds per British horse-power; which represents, also, 1.028 pounds per French brake horse-power, or 1.043 pounds per British brake horse-power. In this trial 3000 liters of water were consumed per hour for washing the gas, and 6100 liters for jacket-cooling.

It is claimed that the Buire-Lencauchez gas producers have obviated the hitherto-existing necessity for using anthracite coal (almost any kind of coal being now available), and that thus the cost of producer gas has been much reduced. This advance is considered as insuring the final supremacy of the gas-engine over all other stationary motors.

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The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

The Machine Shop.

27619. Tool Dressing—The Racker and the Side Tool. Ill. B. F. Spalding (A M–Dec. 13.) 200 w.

27798. Pattern for a Pipe Connecting a Rectangular to a Circular Section. Ill. George Guntz (A M–Dec. 20.) 600 w.

*28030. Crank Building. Ill. G. T. G. (M V–Dec. 21.) 1400 w.

28154. Rebabbitting Boxes. C. R. Tompins (A S–Dec. 29.) 1200 w.

Steam Engineering.

*26884. A Method of Determining the Point of Cut-off Corresponding to a Known Mean Effective Pressure. John H. Barr (S J E–Nov.) 1400 w.

26936. Some Old French Boilers. Ill. (S V–Nov. 15.) 1300 w.

†27232. The Effect of Clearance on the Economy of a Small Steam Engine. Ill. G. W. Bissell (A S M E–Dec.) 600 w.

*27549. California Crude Oil and Its Use as Fuel. A. M. Hunt (I S F–Dec.) 5000 w.

*27575. The Temperature Entropy Diagrams. H. F. W. Burstall (P Eng–Nov. 30.) 2600 w.

27595. The Steam Engine Indicator.—Errors

Due to Reducing Motion. Ill. (Pr–Dec.) 1000 w.

27718. The Engineering of Steam Plants. (E R–Dec. 15.) 2000 w.

27719. Are There Certain General Principles Underlying the Proper Connection of Steam Boilers and Engines in a Power Plant? Theodore F. Scheffler (A G L J–Dec. 17.) 3000 w.

*27764. The Danger of Spring Balance Safety Valves (P Eng–Dec. 7.) 1100 w.

27799. Drop Losses in Multiple Expansion Engines. Charles M. Jones (A M–Dec. 20.) 1500 w.

27800. Selecting a Steam Engine. Frank Gleason (A M–Dec. 20.) 1400 w.

27890. Condensers. Benjamin Thurtell (S E–Dec.) 1500 w.

27891. Theoretical Practice. R. Andresen (S E–Dec.) 2200 w.

27894. Compound Engines (B J C–Dec. 22.) 1100 w.

27896. A Fixed Cut-off and Throttling Regulation vs. Automatic Variable Cut-off for High Expansion Engines (Eng–Dec. 22.) 1800 w.

*27963. The Strength of Short Boilers. Ill. (E–Dec. 14.) 1300 w.

*28006. Test of a Worthington Pumping Engine at Hornsey Sluice. Alexander B. W. Kennedy (P Eng–Dec. 14.) 2000 w.

28022. "Triangular Connecting Rod" Engines. Ill. M. E. (A M–Dec. 27.) 3500 w.

28076. Small Throttling Calorimeters (B J C–Dec. 29.) 1700 w.

28094.—75 cts. Smoke Prevention. Henry J. Williams (T Q–July.) 4200 w.

*28108. Economic Tests of Boilers and Engines (C G–Dec. 21.) 2000 w.

*28129. The Distribution of Steam in Engines (P Eng–Dec. 21.) 3700 w.

*28210. Some Tests Relative to the Production of Steam. Ill. Edward Sauvage (A E R J–Jan.) 2200 w.

28246. Stationary Boiler Practice. By an Engineer (R G–Jan. 4.) 900 w.

28253. The Economical Steam Plant.—Its Design and Operation (B J C–Jan. 5.) 1500 w.

28254. About Steam Gauges—How They May Become Inaccurate (B J C–Jan. 5.) 1400 w.

*28300. The Production and Prevention of Smoke. (Abstract.) Vivian B. Lewes (J G L–Dec. 25.) 3000 w.

Miscellany.

*26811. On the Stiffness of Hemp Ropes and Leather Belting. M. Fauquier (M W–Nov. 9.) 600 w.

27188. How Shall We Gauge Wire and Sheets? Oberlin Smith (Ir Age–Nov. 29.) 4800 w.

*27462. The Professing Mechanical Inventor.—How to be Supplanted—Inspired Genius. Henry Harrison Suplee (E Mag–Feb.) 3000 w.

*27470. Cycle Tires. Ernest M. Bowden (Irm–Dec. 1.) 1200 w.

*27474. The Independent "Chain" Machine.—A Successful New Electrical Undercutting Coal Mining Machine. Ill. (C E–Dec.) 1500 w.

*27488. 320-Horse-Power Simplex Gas Engine and the Pantin Flour Mill. Ill. (Eng L–Nov. 30.) 1500 w.

*27522. The New Wishaw Steel Works of the Glasgow Iron Company. Ill. (E Rev–Nov. 20.) 3500 w.

*27523. The Rise and Progress of Glasgow Industry, with Descriptions of the Principal Works. Ill. (E Rev–Nov. 20.) 9500 w.

†27583. Indian Arts and Industries (I E–Nov. 3.) 1400 w.

27658. Fly-Wheel Accidents. Archibald Sharp (E W–Dec. 15.) 2200 w.

†27794. Experimental Determination of the Quickness of Action of a Shaft Governor, and Theoretical Consideration of the Influence of an Inertia Weight. D. S. Jacobus (S In–Oct.) 1200 w.

27797. The Factor of Safety in Machine Design. William Kent (A M–Dec. 20.) 1200 w.

27807. The Cambon System of Reducing the Number of Accidents in Workshops. Ill. (S V–Dec. 15.) 1000 w.

27813. Progress of Compressed Air (Sc A–Dec. 22.) 2000 w.

27818. The Manufacture of Burglar Proof Vaults. Ill. (Sc A S–Dec. 22.) 1100 w.

27819. Single Cylinder Simplex Gas Motor of 320 Horse Power. Ill. (Sc A S–Dec. 22.) 2500 w.

†27885. Connecticut Work and Workmen. George L. Porter (Tr A M E–Oct.) 3000 w.

27895. Sailing Through the Air.—Successful Trial of Langley's Latest Aeroplane (B J C–Dec. 22.) 500 w.

27898. Pneumatic Tires (Eng–Dec. 22.) 900 w.

*27958. Canet Quick-Firing Artillery. Ill. (E–Dec. 14.) 4500 w.

*27968. The Atlas Works, Glasgow. Ill. (Eng L–Dec. 14.) 8700 w.

*27969. The Smithfield Club Show. Ill. (Eng L–Dec. 14.) 1400 w.

28010. An Excavating and Conveying Cableway Plant at Niagara Falls, Ont. Ill. (E R–Dec. 22.) 1600 w.

28019. Piping for Compressed Air. Frank Richards (A M–Dec. 27.) 2500 w.

28020. Elasticity and Resistance of Materials. Gus. C. Henning (A M–Dec. 27.) 1600 w.

28024. Compressed Air Transmissions with Electrically Heated Compressed Air Engines. Thomas J. Fay (E E N Y–Dec. 26.) 700 w.

*28070. A New Motor Gas Plant. Ill. B. H. Thwaite (E Rev–Dec.) 1700 w.

*28103. The Gigantic Wheel. Ill. (Eng L–Dec. 21.) 1700 w.

*28119. Lilienthal's Experiments in Flying. Ill. (N–Dec. 20.) 1300 w.

28121. Talks to Young Engineers. William O. Webber (M A–Jan.) 1400 w.

*28133. An Astonishing Claim to Mechanical Flight: Achieved "Alone and Almost Unobserved." Editorial (Inv–Dec. 22.) 2400 w.

28172. The Curiosities of Clockwork. Ill. M. Planchon, in La Nature (Sc A–Jan. 5.) 1600 w.

28174. Ball Bearing Axles and Rubber Tires. (Sc A S–Jan. 5.) 4800 w.

28175. The Measurement of Power. Ill. G. D. Hiscox (Sc A S–Jan. 5.) 3200 w.

28177. A Proposed New Standard Screw Thread. Ill. (A M–Jan. 3.) 600 w.

28236. The Future Manufacturing Situs of the United States. Edward Atkinson (T–Jan. 1.) 2500 w.

28292. Small vs Large Machine Shops. W. D. Forbes (I T R–Jan. 3.) 2000 w.

*28312. Hints to Beginners in the Drawing Office. Ill. Ernest Scott (E E L–Dec. 28.) 4000 w.

28334. Pendulum Governors under Working Conditions. F. E. Lammert (Pr–Jan.) 2300 w.

28382. A Cheap Planimeter. Ill. Fred B. Howell (A M–Jan. 10.) 400 w.

Serials.

15534. The Gas Engine (M W–Began June 2, 1893—13 parts to date—30 cts. each).

16781. Rope Driving. Ill. J. J. Flather (E W–Began Oct. 26, 1893—13 parts to date—15 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M–Began Dec. 7, 1893—16 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (El–Began Dec. 1, 1893—29 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M–Began Feb.—10 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E–Began March—11 parts to date—30 cts. each).

21141. High Speed Steam Engines. Ill. John Radinger (E M–Began April—9 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L–Began Aug. 31—11 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Sheffler, Jr. (M A–Began Oct.—4 parts to date—15 cts. each).

25538. Testing of Engines and Boilers. Charles Day (P Eng–Began Sept. 21—8 parts to late—30 cts. each).

25611. Calculation of a Compressed Air Transmission When the Subsidiary Losses of Energy are Taken Into Account. Ill. From Professor Unwin's "Development and Transmission of Power" (E M–Began Oct.—2 parts to date—30 cts. each).

26463. The Slide Rule in the Shop. William Cox (M A–Began Nov.—3 parts to date—15 cts. each).

26661. The Selection of Motive Power. Charles E. Emery (E Mag–Began Jan.—2 parts to date—30 cts. each).

26752. The Cost of Steam Raising. J. Holliday (M W–Began Nov. 2—Ended Dec. 9—4 parts—30 cts. each).

27182. Notes on the Construction and Use of Pressure Gauges. C. R. L. Lemkes (M W–Began Nov. 23—4 parts to date—30 cts. each).

27241. The Law of Invention. Horace Pettit (J F I–Began Dec.—Ended Jan.—2 parts—45 cts. each).

27318. The Buckingham Works, York. Ill. (E–Began Nov. 23—Ended Nov. 30—2 parts—30 cts. each).

27423. Repairing Steam Engines (S M–Began Dec. 1—2 parts to date —15 cts. each).

27520. Gas Power. Ill. J. Emerson Dawson (E Rev–Began Nov. 20—2 parts to date—30 cts. each).

27573. The Modern Development of the Gas Engine. Ill. James Atkinson (P Eng–Began Nov. 30—Ended Dec. 7—2 parts—30 cts. each).

27574. The Stresses on Hemp Ropes and Leather Belts Used for Driving. Ill. M. Fauquier (P Eng–Began Nov. 30—Ended Dec. 7—2 parts—30 cts. each).

27594. Erection of the Corliss Engine. Ill. A. S. Mann (Pr–Began Dec—2 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (M. W–Began Dec. 7—2 parts to date—30 cts. each).

27634. The Principles and Practice of Hydro-extraction. H. B. Ransom (M W–Began Dec. 7—2 parts to date—30 cts. each).

27638. Rope Tramways (I E–Began Nov. 10—1 part to date—45 cts).

27659. Fly-Wheel Accidents. W. Stuart-Smith (E W–Began Dec. 15—2 parts to date—15 cts. each).

27697. Conditions Which Determine the Choice of a Steam Engine. J. W. Hall (I C T–Began Dec. 7—2 parts to date—30 cts. each).

27746. The Reynolds' Smoke Abating Furnace. Ill. (A S–Began Dec. 15—2 parts to date—15 cts. each).

27897. Practical Steam Engineering (Eng–Began Dec. 22—2 parts to date—15 cts. each).

28021. Attachments and Conveniences for Universal Milling Machines. Warren E. Willis (A M–Began Dec. 27—1 part to date—15 cts).

28095. Results of Tests Made in the Engineering Laboratories (T Q–Began July—1 part to date—75 cts).

28115. The Utilization of Wind Power. Rankin Kennedy (E R L–Began Dec. 21—Ended Dec. 28—2 parts—30 cts. each).

28181. The Use of Compressed Air. Anon. (P A–Began Jan. 1—1 part to date—15 cts).

MINING & METALLURGY

The Technology of Explosives.

IN a recent lecture before the Lancashire and Cheshire undermanagers' association Mr. W. J. Orsman gives about as thorough a review of the whole range of modern explosives as it is possible to offer within the prescribed compass. Only a few of the points (which we obtain from the report of the lecture in the *Iron and Coal Trades Review*) will be even mentioned here, but they are of interest especially in the way of a rational classification of the high explosives, the endless variety of which (at least so far as is indicated by the long string of trade names) is bewildering, unless some such grouping is borne in mind.

Notwithstanding the large number of explosives known and suggested, all of them, says Mr. Orsman, derive their explosive properties from two causes,—namely, the results of heat and pressure. "Explosion may therefore be caused by intensely rapid combustion, and as a general rule explosives owe their force to the generation of pressure, caused by rapid decomposition, or by combination of certain elements, the products formed being largely expanded by the heat evolved, and the destructive effect being regulated by the time taken in producing the change of state. All ordinary explosives consist of two parts,—the combustible elements and the oxidizing body." Thus common gunpowder—a mechanical mixture—has an average composition of about: potassium nitrate, 75; charcoal (carbon), 15; sulphur, 10 parts. For different purposes it varies somewhat. A cheap black blasting powder consists of: nitrate, 65; charcoal, 15; sulphur, 20 parts. Until quite recently the superiority of gunpowder for ordnance depended on the fact that it is possible to regulate the speed of combustion and arrange that the powder shall commence to burn comparatively slowly, so as to gradually overcome the inertia of the projectile without too great strain, while the combustion shall increase so rapidly as to give the maximum impulse (and highest velocity) as the projectile reaches the muzzle. To produce this result artillery powders—such as the cocoa powder—are much slower in burning than ordinary gunpowder, and average about: nitrate, 79; carbon, 18; sulphur, 3 parts. The chemical reactions which take place when gunpowder burns depend on the method of firing and whether it is loose or confined. It has the two combustible elements, carbon and sulphur, and the oxidizing salt, potassium nitrate, which contains as much oxygen as 3000 times its own volume of air. The oxygen combines with the carbon to form carbon dioxide and monoxide; the sulphur (added to expedite composition) combines with oxygen and potassium, forming potassium sulphate. One cubic inch of powder yields about 270 cubic inches of gas, measured when cold, which is expanded by the heat of combustion to nearly 3000 cubic inches, and, if confined, would exert a pressure of about 30 tons per square inch. The smoke consists mainly of finely divided particles of potassium sulphate, with some potassium carbonate and other compounds, and amounts to over 50 per cent. by weight of the total products of combustion. In "smokeless" powders the object is to have the products of combustion entirely gaseous.

The gun-cotton family of explosives are made by the action of strong nitric acid on cotton, paper, starch, sawdust, and other similar organic substances. Gun-cotton, etc., differ from gunpowder in that they do not consist of a mechanical mixture, but are chemical compounds containing the combustibles and the store of oxygen in the same molecule. The action depends upon mode of firing and confinement. Nitrated sawdust was an early advance in the line of smokeless powders. Then followed the method of dissolving nitrated cotton in a volatile solvent, evaporating the solvent off, and molding the remaining horn-like material into various forms. Later, good results have been obtained by dissolving an excess of nitro-cotton in nitro-glycerine with the aid of a small proportion of camphor, giving a product that can be molded or rolled into sheets. Cordite is a new preparation of the same class, supposed to be of more stable composition, and is made in the form of wires or rods. In all these and other high explosives the great question is whether they will withstand, unchanged and unharmed, the vicissitudes of climate, transport, and storage.

Up to 1868 the firing of explosives was accomplished by simple application of heat. Then the discovery that decomposition could be brought about by intense shock, and with intensified effects, led to the introduction of detonators ("caps") containing fulminate of mercury. The explanation of the apparent paradox of such a small quantity of fulminate causing the decomposition of an unlimited quantity of high explosive, according to Berthelot, is that "the shock of the primary explosion communicates to the layer of molecules in the immediate proximity an enormously active force, whereby the 'molecular edifice' is shaken to pieces and the initial force is augmented to a degree corresponding to the heat evolved by decomposition. A new shock is thereby produced in the next layer, and the action is repeated and so propagated until the whole molecular system is completely destroyed." These effects are almost instantaneous. Gun-cotton can be detonated even if it is wet.

Glycerine was nitrated by Sobrero in 1845, but it was not until 1863 that the value of nitro-glycerine as an explosive was demonstrated by Nobel. Being a liquid and easily exploded, many accidents occurred from leakage. To obviate this danger, Nobel formed certain plastic preparations (the dynamite group) by mixing nitro-glycerine with absorbents. Giant powder, one of the most important combinations, consists of nitro-glycerine absorbed (in various proportions) by kieselguhr, a porous silicious earth composed of the remains of microscopic animalculæ. This inert absorbent is replaced in some other explosives of the class by other substances which are themselves combustible or even explosive.

Blasting gelatine (said to be the most powerful explosive, bulk for bulk, now in use) is made by dissolving nitro-cotton in nitro-glycerine, the latter losing its fluidity, the product being a jelly-like mass.

Picric acid (tri-nitro-phenol) is prepared by acting on carbolic acid (phenol) with nitric acid. It can be detonated by fulminate. Potassium picrate was introduced about twenty-five years ago, and improved upon by the substitution of ammonium picrate. Picric acid is made less sensitive to percussion by being melted and poured while in a molten state into shells, or by making the grains into a solid mass with collodion an increased weight of explosive can be got into a given space. Melinite, the French military explosive, is said to be a picrate.

The Sprengel group of explosives are mixtures of two solids, or of a solid and a liquid, or of two liquids—one of which is a hydrocarbon, containing carbon and hydrogen in a condition favorable to rapid combustion, while the second is an easily decomposable substance rich in oxygen. The two constituents are for safety kept and transported separately, and mixed, in definite proportions, just before using. Rack-a-rock, a mixture of potassium chlorate and petroleum, is the best known type and is much used in blasting. Benzine, benzol, etc., are substitutes for petroleum. Hellhoffite, a mixture of nitrated tar oils with the strongest nitric acid, and oxonite, containing picric and nitric acids, belong to this class, and are mixed when they are to be used. The use of the foregoing explosives is prohibited in England because they are believed to be specially sensitive and more or less unstable after being once mixed; and in 1886 a new group of explosives was introduced, consisting of di-nitro-benzol, or nitro-naphthaline, mixed with either ammonium nitrate or potassium nitrate. Ammonite, bellite, roburite, and securite are the principal explosives of this class, and are much used in mining work. Roburite, which seems to be the especial favorite of Mr. Orsman, is a typical example. It is a simple mixture of ammonium nitrate with chlorinated meta-di-nitro-benzol. It is deliquescent, and consequently the finished explosive must be kept in waterproof cartridges, out of contact with the atmosphere, made so by dipping in melted wax. It is claimed that, unlike gunpowder and the nitro compounds and mixtures of other classes, it is impossible to explode roburite by percussion, fire, or electric spark, but only by a detonating wave such as is produced by fulminate of mercury. Mr. Orsman lays down the following conditions for safety explosives to be used in dusty or gaseous coal mines, and states that roburite fulfils them: (1) The temperature of detonation must be as low as possible; (2) the products of decomposition must be entirely gaseous and non-combustible; (3) the explosive must not be liable to detonate except by means of a detonator; (4) it must not be liable to ignition by spark, fire, or partial miss-shot; (5) the resultant fumes must not be poisonous; (6) the cartridge must not be liable to freeze. The author here omits to mention some other important conditions, as strength, stability, and certainty of complete detonation at the proper moment. He points out further on, however, that with safety explosives, and in fact with all explosives, the danger lies in the possibility of incomplete combustion, which can only be overcome by having an excess of available oxygen; but this unfortunately means greatly increased temperature. To tone down the temperature of nitro-glycerine compounds, wood meal, as in carbonite, has been introduced, but is said to produce carbon monoxide, a poisonous gas, although a fair degree of safety is attained. The latest explosive of the Sprengel type is westphallite, an intimate mixture of ammonium nitrate with resin or shellac, which requires a very strong detonator.

Mr. Orsman's conclusion as to safety explosives is: "No explosive in which complete detonation takes place ever has been, or, I venture to think, ever will be, produced that will not generate sufficient heat to ignite an explosive mixture of gas." This discouraging dictum will of course be vigorously assailed by the advocates of the many newly introduced or proposed safety explosives, but should give comfort to the friend of the water cartridge, the lime cartridge, etc.

Hydraulic Mining in California.

UNDER the caption, "A History of the Miners' Movement," the *Mining and Scientific Press*, of San Francisco, reviews the course of the long and bitter struggle between the farmers and placer-miners of California, its effects, the attempts at compromise for the purpose of resuming hydraulic mining under restrictions, legislation regarding the matter, and the present condition of the industry. The subject is one of more than local importance, since the enforced suspension of this branch of mining meant that a supply of about $10,000,000 in gold annually had been shut off, and that, unless some mode of rehabilitating it were found, the enormous reserves of auriferous gravel would be left unavailable. Most of the readers of this Magazine are doubtless more or less familiar with the subject, but an abstract of the article in the *Press* may serve to put it in a clearer light.

While the gravel mines of California worked by the hydraulic method had been yielding many millions of dollars yearly, they had at the same time been pouring forth a flood of *débris* (tailings) into the river channels, obstructing the navigable streams and adjacent farming lands. The farmers whose property was damaged started what is known as the "anti-*débris*" agitation, and a long-continued litigation in the courts ensued; finally, in a test case, a decision in favor of the farmers enabled them to obtain injunctions closing mine after mine, until at last practically all the mines discharging tailings into the interior drainage basin were forced to cease operations. For many years hydraulic mining in California was dead, so far as the principal district was concerned. The miners were in the minority. At first the decisions of the courts met with general aproval outside the mining regions. The istress was great, but appeared to be conined to the mining communities, in hich, of course, everything was at a tandstill, with men out of work, all the nterests dependent upon hydraulic mining tagnant, and some of the towns almost epopulated. But the trouble spread. he decisions against miners amounted to practical confiscation of their property. t was shown during the trials that upards of $100,000,000 had been invested in he hydraulic mines, ditches, etc., and virually wiped out. The mines could not be orked under the rulings, nor could they e sold. This condition of affairs affected ot only the miners and the local tradeseople, mechanics, and others associated ith them, but the outside investors and he State at large.

After ten or twelve years of stagnation, he first signs of a revival were shown by he action of the governor and legislature n seeking for a remedy, which, under the onditions, seemed out of their own reach. The legislature memorialized congress to ppoint a commission to examine the rivers and hydraulic mines and take such measures as would enable the mines to be reopened. In the meantime another commission previously appointed reported in avor of building retaining dams for the *débris*. The miners, becoming encouraged by the hope of resuming operations, held a convention in January, 1892, to which representatives from the farmers were invited. The latter had suffered as well as the miners, and a reconciliation was effected, the miners expressing themselves as willing to impound their *débris* in the future, and the farmers withdrawing their opposition on that understanding. A State miners' association was organized, which has been very active and has been supported by all classes. After a struggle, the Caminetti bill was passed by congress. It was an unsatisfactory measure, but formed the basis of an arrangement by which hydraulic mining might be resumed under restrictions.

Under the federal and State concurrent aws the miners, in order to work claims y the hydraulic method, must provide impounding works in which to retain the tailings. The whole matter of operating is placed in the hands of the State *débris* commission, which alone has the right to issue licenses to mine in the central drainage basin. Under these conditions the output of the mines is limited by the capacity of the settling reservoirs, and they cannot be as productive or profitable as formerly, when without restrictions. At present about fifty hydraulic mines are working in the district affected by the *débris* question, while many applications for licenses are pending. Before the present law was passed, all of these mines could have been enjoined. There are still two bills pending in congress relating to the matter, and there is much controversy over them.

Iron or Steel Head Frames.

THE *Colliery Engineer* has an illustrated article on the history of iron and steel head frames at Pennsylvania coal mines and their advantages over timber frames, which will command the attention of mine managers elsewhere. The first iron head frame for a shaft in Pennsylvania, and probably the first in America, was built by the Philadelphia & Reading C. & I. Co., at the Pottsville shaft, but, as it was located at an unprofitable opening, it did not receive much attention, and therefore had little effect in advancing the use of such head frames at other mines. The first steel head frames for productive Pennsylvania collieries were erected at the Oliver mine and at the Connellsville mines of the H. C. Frick Coke Co. These being found successful, others were speedily built, until now steel head frames are common in western Pennsylvania. The first steel head frame in the anthracite region was put up at the Nottingham colliery, Plymouth, where 633,000 tons of coal are hoisted through one shaft to the top of one breaker, the wear and tear on the tower being very heavy. At Richmond No. 4 shaft, near Carbondale, is a steel head frame one hundred and eighty-seven feet high, with a base fifty-two feet square, the great height being necessary to give grade for a shoot to the top of the breaker, which, in accordance with the State anthracite mine law, has to be at least two hundred feet from the shaft. Self-dumping cages are used. This was a radical departure from the usual method of handling coal, but it meets with general approval. It is estimated that the saving by the use of steel in this case is at least sixteen hundred dollars a year, not allowing for the fact that wooden head frames must be renewed every six or eight years, while it is thought that, when the colliery is exhausted, the steel in the tower and shoot will have a market value of about two-thirds its original cost.

Mica in Alabama.

IN *The Tradesman* Mr. Wm. Brewer gives an account of the present condition of mica mining in Alabama, in which State, he says, investigation proves that there are three distinct belts of coarse-grained granite containing mica of commercial value. These belts have the general northeast-southwest trend of the other mineral belts in the crystalline rocks of the region. The most extensive work has been done on the northernmost, in Randolph county, but the distance from railroads and the high cost of wagon-haulage are great drawbacks. The workings are shallow. "In order," says Mr. Brewer, "that mica mining may be profitable, deep mining is necessary. In a word, water level must be reached before profitable results can possibly follow, for these reasons: (1) The mica crystals near the surface are nearly all more or less stained with iron oxid. (2) The mica sheets near the surface are nearly always very much cracked, broken, and rotten; consequently less than two per cent. of the product is merchantable. (3) Below water level, wherever such depth has been attained, the quality and size of the crystals are much superior, and the quantity of marketable mica is a much larger percentage." Speaking of the industry at large, the author states that, although mica mining is really one of the older mining industries of the country, it is only recently that the demand for mica has been otherwise than limited. To-day the demand is really in excess of the supply so far as home mining is concerned and most of the mica used in the United States is imported from Canada and India. This increased demand is due to the extensive use of mica in electrical appliances. The demand for ground mica, for which the waste from dressing the sheets can nearly all be used, is also increasing, this product being used as an ingredient in lubricants for heavy bearings and in certain insulating compounds. Scrap mica is now being made into large artificial sheets, under the trade name of "micanite."

On the whole, "mica mining," says Mr. Brewer, "is, to tell the exact truth, one of the most hazardous kinds of mining, because, while the mineral occurs in veins, yet these always have a lenticular shape, connected by stringers the product of which is rarely sufficient to pay expenses; and indeed sometimes the pockets are entirely unconnected, except by the continuity of the quartz and feldspar constituents of the granite, with small crystals and flakes of mica. Consequently mining is costly, as well as for the additional reason that at best from four to six per cent. only of the total product is marketable. In fact, the percentage is often less, especially near the surface." A good deal of misunderstanding prevails with regard to the price of mica. Lists quoting it from five cents to thirteen dollars a pound are misleading. "As a matter of fact, the largest consumers limit their price between five cents and one dollar a pound, according to size, and have no trouble in purchasing all they desire at these prices." But the author considers that the constant increase in the demand, while the supply is limited, should encourage the owners of mica properties to work them, and to endeavor to lessen the cost of mining and dressing in order to enable them to compete with foreign producers.

The Dahlonega Gold-Mining District.

THIS historic gold field is still the scene of active mining operations,—conducted not on a very large scale, but successfully and economically, and worthy of note because of the peculiar methods pursued. Lumpkin county, Georgia, in which it is situated, has the reputation of having produced more gold in the past sixty-nine years than any other portion of the southern United States. Prof. Wm. M. Brewer contributes to the *Engineering and Mining Journal* an interesting account of the present condition of the field, from which it appears that seven mines, with mills of from ten to forty stamps each, are now actively worked, besides one dredge-boat on the Chestatee river, and a number of men working in a small way sluicing on leased ground. Altogether about three hundred men are engaged in gold mining in the district. There are nearly eighty miles of ditches and flumes, the main canal carrying six hundred miner's inches. The mills are all run by water power. The usual system of mining is a combination of hydraulic mining and transport, and milling the quartz. No deep mining has been done on any location. The mines so far developed are on parallel leads in a semi-crystalline state, overlaid by schists and gneiss, the latter graduating into granite. Much of the ore occurs in hornblende and gneissoid schists, in narrow seams of quartz, much decomposed at the surface, which explains the reason for adopting the combination system of mining. The material is blasted or picked and broken in open cuts on the mountain side and transported through sluices to the ore bins at the mills, where it is fed by hand into the mortars, and amalgamated. A portion of the length of the sluices is lined with riffles, which catch the coarse gold. The cost of mining and milling is stated at only twenty-five cents a ton, and the average yield at two dollars. This extremely low cost (which compares favorably with the famous record of the Spanish mine, California) is accounted for by the fact that miners' and millmen's wages are only eighty cents to one dollar a day, and that water is the only power used for transportation and running the machinery. Up to the present time no attempt has been made to concentrate and save the sulphurets, although some of the ore contains much. Experiments are now being made in this direction. A dredging company is excavating a canal to drain the bed of the Chestatee river, which, with two hundred and fifty acres of placer ground, will be the center of its operations. In this plant electricity derived from water power is used for pumping.

The Boom in Gold Mining.

THE London *Mining Journal* calls attention to the boom which has lately set in in the gold mining industry, or rather to the revival of the speculative interest, and says that the temper of the speculating public is hard to forecast. After deserting the mining share market for a long time, during which there were ample opportunities for making money in this class of investments, it has suddenly started a boom in them, and this in advance of a revival in other interests. The *Journal* had predicted that a renewal of speculation would take this particular direction, because the experience of the English public had been less disastrous in mining than in other foreign industries. But the *Mining Journal* considers it surprising that the excitement should have confined itself so strongly to new mining enterprises, ignoring the old. Thus the boom in the new Western Australian mines has been quite unattended with a similar movement in the shares of the smaller of the South African mines, and our contemporary states that there has been a considerable withdrawal of English support from these mines, while recent purchases have been mostly on account of German and French capitalists. This the *Journal* ascribes to the strong interest which the charm of novelty exerts even in the prosaic regions of finance. While the *Journal* has recognized the importance of the new discoveries, it now sounds a note of warning against overdoing the matter, and intimates that the promoters have taken advantage of the prevailing popular feeling to float many doubtful projects. A comparison is drawn between the now well ascertained continuity and regularity of the Transvaal deposits and the unknown conditions of some of the Western Australian properties lately put upon the market, and the inference is not flattering to the latter. This, however, is something often paralleled. The *Journal* does not in the article quoted refer to the recent and continuing interest in American gold mines, and more especially to those in newly found districts; and it might be added that the depression in silver mining has had much to do with the transfer of attention to gold mining.

In a later issue of the same periodical, under the heading "The Future of Gold Mining," a continued upward movement in the shares of gold-mining companies is chronicled. This is considered by the *Mining Journal* to be due not so much to speculation as to the perception of the fact that these stocks had been greatly undervalued; and the large purchases on European account of shares in the dividend-paying properties of the Rand (Transvaal) appear to have been made for permanent investment. As to the Rand mines, within a short time several hundred additional stamps will be crushing ore; the recent improvements in cyanide extraction are claimed to mean a saving of forty per cent. in this part of the working expenses, while the introduction of electrical power transmission from central plants will result in another large saving in cost of motive power. The outlook in this district is believed to be extremely favorable.

Industries and Iron states that the electrolytic separation of manganese from its compounds is now performed at an establishment in Hanover, the metal so obtained being absolutely pure. It is in the form of a fine powder. To prevent loss in the crucibles consequent upon this condition alkaline chlorides are used in fusing.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

27395. Malleable Castings from Coke Pig Iron. Ill. (Ir Age–Dec. 6.) 600 w.

27602. The Electro-Metallurgy of Gold and Silver. A. L. Eltonhead (E R N Y–Dec. 12.) 2500 w.

27615. Surface Defects in Ingots. J. S. Robeson (Ir Age–Dec. 13) 2800 w.

27620. Economy in Melting. Herbert M. Kamp (A M–Dec. 13.) 1600 w.

27713. Stone Coal in the Lead Blast Furnace. L. S. Austin (E M J–Dec. 18.) 1000 w.

*27737. Soldering of Aluminum and the Production of the Metal in Great Britain (Inv–Dec. 8.) 1100 w.

*27743. The Determination of Tin and Antimony in Commercial Samples. J. H. Digger (C T J–Dec. 8.) 800 w.

†27793. The Determination of Carbon in Iron and Steel. Theodore B. Stillman (S In–Oct.) 3500 w.

27795. Relative Tests of Cast Iron. W. J. Keep, with Discussion (Ir Age–Dec. 20.) 6400 w.

27863. The Use of Alloys in the Manufacture of Brass and Bronze Castings. F. J. Davis (F D–Dec.) 1100 w.

†27876. Does the Vibration of Stamp-Stains Change Their Molecular Structure? Continued Discussion of Mr. Rickards' paper on "The Limitations of the Gold Stamp-Mill." (Tr A M E–Oct.) 9000 w.

†27877. Early Days of the Iron Manufacture. John Fritz (Tr A M E–Oct.) 7000 w.

†27879. A Uniform Method for the Assay of Copper Materials for Gold and Silver. Discussion of paper by Albert Ledoux (Tr A M E–Oct.) 2200 w.

†27880. Magnesia and Sulphur in Blast-Furnace Cinder. Frank Firmstone. Discussion. (Tr A M E–Oct.) 1300 w.

†27881. Losses of Gold and Silver in the Fire-Assay. H. Van F. Furman (Tr A M E–Oct.) 2000 w.

†27882. Pyrometry and the Heat-Treatment of Steel. Henry M. Howe (Tr A M E-Oct.) 1000 w.

†27883. The Inaccuracy of the Commercial Assay for Silver. Discussion of the paper of C. A. Stetefeldt (Tr A M E–Oct.) 1200 w.

†27884. Further Experiments on Amorphous Gold. Henry Louis (Tr A M E–Oct.) 1800 w.

*27918. The Fuel Element in Blast Furnaces. E. de Billy (C G–Dec. 14.) 4000 w.

*27920. The Removal of Clay from Iron Ores. Walter J. May (C G–Dec. 14.) 1000 w.

*27971. Face Hardened Armor in the United States. Editorial (Eng L–Dec. 14.) 1400 w.

27980. Machine Molding. Harris Tabor, with Discussion (Ir Age–Dec. 27.) 5200 w.

†28086. The Future of Gold. Robert E. Preston (N A R–Jan.) 3000 w.

*28105. Presidential Address of J. E. Stead (C G–Dec. 21.) 2500 w.

28157. The Chicago Iron Trade in 1894 (Ir Age–Jan. 3.) 3500 w.

28158. The Pittsburg Iron Trade in 1894 Ir Age-Jan. 3.) 3600 w.

†28192. Melting and Refining Gold Bullion. I. Van F. Furman (S M Q-Nov.) 2500 w.

†28235. The Resistance to Corrosion of Some ight Aluminum Alloys. Joseph W. Richards J F I-Jan.) 900 w.

28242. The Manufacture of Iron in the South. Villiam M. Bowron (T-Jan. 1.) 5500 w.

28243. Southern Rolling Mills. W. H. Hasinger (T-Jan. 1.) 2200 w.

28245. Will the South Manufacture Steel? Symposium by Prominent Iron Masters of the Country (T-Jan. 1.) 4500 w.

28288. Fine Ores in the Blast Furnace. F. . Richards (I T R-Jan 3.) 1700 w.

28293. Improvement in Foundry Methods—Views of Practical Men on Recent Developments I T R-Jan. 3.) 1800 w.

28294. New York Metal Market, 1894 (E M -Jan. 5.) 5000 w.

28295. Review of Boston Copper Stocks in 894 (E M J-Jan. 5.) 1200 w.

28306. The Evolution of the Art Idea in merican Hardware. A. W. D. (A S-Jan 5.) 000 w.

*28350. Recent Progress in the Manufacture f Steel. (Abstract.) James Riley (I C T-Dec. 8.) 3400 w.

*28351. On the Condition of Carbon in Steel. (Abstract.) F. A. Matthewman (I C T-Dec. 28.) 1300 w.

MINING.

26523. Gold Mining in Ecuador. A. F. Saaye (E M J-Nov. 3.) 1300 w.

*26941. The Boom in Gold Mining. Editoial (M J-Nov. 10.) 700 w.

*26958. The Technology of Explosives. W. . Orsman (I C T-Nov. 9.) 3500 w.

*27472. Electricity in Coal Mining.—A Sucessful Haulage and Pumping Plant. Ill. (C E-Dec.) 1800 w.

*27473. Iron or Steel Head Frames.—Their Superiority Over Timber Head Frames for Shafts. Ill. (C E-Dec.) 1300 w.

*27489. Flameless Explosives. Editorial Eng L-Nov. 30.) 2100 w.

*27491. Report on Flameless Explosives. A. . Kayll, with Discussion (C G-Nov. 30.) 500 w.

*27492. Determination of Firedamp by the imits of Inflammability. M. Lebreton (C G-Nov. 30.) 3000 w.

*27493. Australian Coal (C G-Nov. 30.) 500 w.

*27494. Motive Power Economically Obained from Coal (C G-Nov. 30.) 1500 w.

*27495. The Munzer Brake-Parachute for ine Cages. Ill. (C G-Nov. 30.) 3800 w.

*27496. Coal Mining in New Zealand. A. Cadman (C G-Nov. 30.) 1300 w.

*27497. The Generation of Electricity at Collieries. Walter J. May (C G-Nov. 30.) 1000 w.

*27498. The Baker Naphtha Industry (C G-Nov. 30.) 1100 w.

27535. Cochiti, New Mexico (M I T-Dec. 8.) 1200 w.

†27584. Faulting—Its Causes and Results. Ill. (I E-Nov. 3.) 1500 w.

*27589. The Safety of High Explosives (I C T-Nov. 30.) 2200 w.

27612. Vanderbilt Mining District. Fred E. Lewis (M S P-Dec. 8.) 2000 w.

†27639. The Coolgardie Goldfield. R. W. W. (I E-Nov. 10.) 1200 w.

*27681. The Belgian United Frameries Collieries (C G-Dec. 7.) 2500 w.

*27682. The Law Respecting Ways and Wayleaves (C G-Dec. 7.) 3000 w.

*27683. Explosions of Firedamp and Rapid Barometrical Depressions (C G-Dec. 7.) 1000 w.

*27684. Petroleum and Natural Gas. (Abstract.) Henry M. Cadell (C G-Dec. 7.) 5000 w.

*27685. The Coalfields of New Zealand (C G-Dec. 7.) 4000 w.

27709. Mica in Alabama. William Brewer (T-Dec. 15.) 1200 w.

27714. The Dahlonega Gold Mining District. Ill. William M. Brewer (E M J-Dec. 15.) 1200 w.

*27749. The Future of Gold Mining (M J-Dec. 8.) 700 w.

*27753. The Slate Quarries of Angers, France. Ill. (S-Dec.) 2000 w.

*27754. Granites of England. From a Monograph by Hyjalmar Lundbohm (S-Dec.) 1600 w.

*27777. The Coolgardie Goldfields (W. A.) —An Adverse View (A M S-Nov. 10.) 1100 w.

*27779. Electricity in Mines. W. E. Lishman (A M S-Nov. 17.) 2700 w.

27820. Gold Mining in Georgia (M R-Dec. 21.) 1200 w.

27831. Canals for Hydraulic Mining (Min R-Dec. 6.) 1000 w.

27858. The Rainy Lake Gold District (E M J-Dec. 22.) 1107 w.

27859. The Mineral and Metal Production of Sweden in 1893 (E M J-Dec. 22.) 1000 w.

†27878. The Nickel Mine of Lancaster Gap, Pennsylvania, and the Pyrrhotite Deposits at Anthony's Nose, on the Hudson. Ill. J. F. Kemp (Tr A M E-Oct.) 4200 w.

†27886. The Phosphates of Tennessee. Thomas C. Meadows and Lytle Brown (Tr A M E-Oct.) 4000 w.

†27887. The Mines of the Chalanches, France. T. A. Rickard (Tr A M E-Oct.) 5000 w.

†27888. Lead and Zinc Deposits of Missouri. Ill. Arthur Winslow (Tr A M E-Oct.) 19500 w.

†27889. The New Mining Law of New York. R. W. Raymond (Tr A M E–Oct.) 10500 w.

*27917. Exploration and Working of Coal and Iron in France (C G–Dec. 14.) 1100 w.

*27919. Colliery Surface Works (C G–Dec. 14.) 1000 w.

*27921. On the Influence of the Diameter of Holes in Blasting Operations. James Ashworth (C G–Dec. 14.) 1600 w.

27938. Coal in Peru (A M & I W–Dec. 21.) 1500 w.

28059. Mica; Its Uses, Mining and Trade in India. Edgar Thurston (C M R–Dec.) 4500 w.

28066. The Leadville District, Colorado, in 1894 (E M J–Dec. 29.) 400 w.

28067. Gold in Zacatecas, Mexico. Edward Halse (E M J–Dec. 29.) 1500 w.

28068. The Mining Exposition at Santiago, Chile (E M J–Dec. 29.) 800 w.

*28106. The Trien-Kaisin Colliery, Belgium, at the Antwerp Exhibition. Ill. (C G–Dec. 21.) 1700 w.

*28107. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (C G–Dec. 21.) 1000 w.

*28109. Substitution of Masonry for Timber Lining Without Interruption to Winding or Pumping. Ill. (Extract.) Julien Linet (C G–Dec. 21.) 2200 w.

*28110. Blasting Explosives (C G–Dec. 21.) 1900 w.

†28191. Spring-Pole Drilling. Ill. Edgar T. Tuttle (S M Q–Nov.) 6400 w.

†28193. Electricity for Mining Plants. Eduard D. Self (S M Q–Nov.) 1700 w.

28207. S. B. Christy's Address before the California Miners' Association (M S P–Dec. 29.) 3500 w.

28240. The Mineral Resources of the South. W. M. Brewer (T–Jan. 1.) 9000 w.

28286. Coal Fields in New South Wales (A M & I W–Jan. 4.) 800 w.

28290. Mesabi Mining Costs. Ill. H. V. Winchell (I T R–Jan. 3.) 3200 w.

28291. Ores of the Mesabi Range. Richard A. Parker (I T R–Jan. 3.) 3300 w.

*28328. The Urikany and Zsil Collieries, Hungary (C G–Dec. 28.) 1800 w.

*28330. Rodde's Safety Lamp. Ill. (C G–Dec. 28.) 2300 w.

*28347. Explosions in Mines. (Abstract.) Vivian B. Lewes (N–Dec. 27.) 1800 w.

Serials.

20413. Mining Methods. Ill. (C E–Began March—10 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E–Began March—10 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E–Began March—10 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E–Began March—10 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng–Began April 27—11 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons (M S P–Began June 2—17 parts to date—15 cts. each).

22710. Science for Iron-Mongers (Irm–Began June 2—13 parts to date—30 cts. each).

25689. A Typical Gold Mine Region—Cripple Creek, Col. Ill. Arthur Lakes (C E–Began Oct.—3 parts to date—30 cts. each).

26031. European Phosphates. C. C. Hoyar-Millar (M R–Began Oct. 19—7 parts to date—15 cts. each).

26139. Aluminum. A. Humboldt Sexton (P Eng–Began Oct. 12—3 parts to date—30 cts. each).

26386. Proper Foundry Construction and the Apparatus to be Used. Simpson Ballard (T–Began Nov. 1—4 parts to date—15 cts. each).

26816. Notes on the Gold-Bearing Black Sands of California. J. A. Edman (M S P–Began Nov. 10—Ended Dec. 15—3 parts—15 cts. each).

26826. Open Hearth Steel. Ill. (Ir Age–Began Nov. 15—5 parts to date—15 cts. each).

27111. The Profits of Gold Mining. Nicol Brown (M J–Began Nov. 17—Ended Dec. 1—3 parts—30 cts. each).

27319. The Mineral Resources of the United States (E–Began Nov. 23—Ended Nov. 30—2 parts—30 cts. each).

27329. Coal Mining Economy up to Date (I C T–Began Nov. 23—3 parts to date—30 cts. each).

27356. Further Experiments on Amorphous Gold. Henry Louis (M J–Began Nov. 24—Ended Dec. 1—2 parts—30 cts. each).

27357. The Practical Operation of the Cyanide Process in the Randt. M. Eissler (M J–Began Nov. 24—Ended Dec. 1—3 parts—30 cts. each).

27358. Motive Power for Mining Machinery (M J–Began Nov. 24—5 parts to date—30 cts. each).

27450. Cupola Tuyeres. Ill. Edward Kirk (Met W–Began Dec. 8—2 parts to date—15 cts. each).

27700. Aluminum. G. B. E. (I & I–Began Dec. 7—2 parts to date—30 cts. each).

27715. The New Mining Law of New York. R. W. Raymond (E M J–Began Dec. 15—2 parts to date—15 cts. each).

27937. Coal Development on the Chesapeake and Ohio Railroad. J. D. Imboden (A M & I W–Began Dec. 21—2 parts to date—15 cts. each).

27975. The Present Status of Face Hardened Armor. (Abstract.) W. T. Sampson (I & I–Began Dec. 14.—2 parts to date 30 cts. each).

28038. The Extraction of Copper from Alloys by Means of Electrolysis. From Dr. Carl Schnabel's Handbook (A M S–Began Nov. 24—1 part to date—30 cts).

28130. Mining Reports and Mine Salting. Walter McDermott (M J–Began Dec. 22—1 part to date—30 cts).

MUNICIPAL ENGINEERING

he Physical Qualities of Building- and Paving-Bricks.

A VERY extensive table of results of Tests of Paving-Bricks" prepared by Mr. . S. Fickes, of Steubenville, Ohio, who so made the tests, is printed in *Engineer-g News* (Dec. 18). The amount of work presented in this table is large. Samples f bricks from no less than thirty-four idely separated localities in the United tates are tabulated,—often a considerable umber of samples from the same locality; that one hundred and one different mples are represented. For example, x samples from Canton, Ohio, seven from leveland, eleven from St. Louis, ten from hiladelphia, and four from New Cumber-nd, W. Va., are represented.

Commenting editorially upon this table, *ngineering News* points out that its value enhanced from the fact that the tests ere all made by the same experimenter, d by the same methods and apparatus. hese methods being reliable and accu-te, the tabulated results ought to be very early correct. The table represents pav-g-bricks from twelve different cities, the ther samples being building-bricks. An xhaustive analysis of the tabulated results ables the following rules for paving-ricks to be deduced.

"1. Paving-bricks are best tested by eir resistance to abrasion when tumbled, d they vary considerably in that respect, me losing nearly three times as much eight as others for a given amount of mbling.

"2. Any brick which will stand tumbling ell has ample crushing strength, rarely ipping under less than five thousand ounds per square inch, or crushing under ss than ten thousand pounds. The ushing strength tends to vary with the sistance to abrasion, however, but more owly and irregularly.

"3. The transverse strength also tends vary with the resistance to abrasion, ut more slowly and irregularly. Good paving-brick should show a modulus of two thousand to two thousand five hundred under transverse load, but brick with small resistance to abrasion will often show high transverse strength, so that the test has only negative value.

"4. The quantity of water absorbed in twenty-four hours should be small, as an end in itself, but it is a very rude test of the quality of the bricks in other respects. The toughest bricks tend to show the least absorption, and any paving-brick absorbing much more than one per cent. of moisture in twenty-four hours is justly open to suspicion; but some of the best bricks will absorb more than thirteen per cent. of water, and some of the poorest bricks will absorb much less. All good paving-bricks absorb less than two per cent., which is greatly less than the best building-bricks absorb."

For building-bricks a different set of rules is deduced, although this has been a more difficult task than it was to draw conclusions applicable to paving-bricks, requiring a rearrangement of the tests in the order of ultimate crushing strength per square inch, and subdivision into groups as follows: crushing strength—(A) 8,000 per square inch, and over; (B) 6,000 to 8,000; (C) 5,000 to 6,000; (D) under 5,000.

"1. The strength of building-brick, both transverse and crushing, varies in tolerably close inverse ratio with the quantity of water absorbed in twenty-four hours. The strongest bricks absorb least water.

"2. Good building-bricks absorb from six to twelve per cent. of water in twenty-four hours, and, with no greater absorption than twelve per cent., will ordinarily show from seven thousand to ten thousand or more pounds, per square inch, of ultimate crushing strength, and a transverse modulus of seven hundred to twelve hundred pounds or more.

"3. Poor building-bricks will absorb from one-seventh to one-fourth of their weight of water in twenty-four hours, and average a little more than half the transverse and crushing strength of good bricks.

"4. An immersed brick is nearly saturated in the first hour of immersion; in the remaining twenty-four hours the absorption is only one-half to four-fifths of one per cent. of its weight, as a rule.

"5. The strength of bricks in the kiln is least in the top course, and increases quite rapidly for the first ten or twelve courses, and afterwards more slowly down to the arch bricks.

"6. The size of bricks varies greatly in different parts of the country, the weight varying from 3.84 to 6.34 pounds. The Eastern bricks tend to smaller sizes than do the Western, but the variation is often considerable in different makes of bricks in the same locality.

"7. Bricks made by the dry press are, as a rule, notably less porous and stronger than those made by the wet mud process. To this rule, however, there are some exceptions."

Drinking-Water in its Relation to Malarial Diseases.

MANY years ago one of two contiguous families residing in an eastern town in the United States was seriously affected with malarial diseases, while the other remained in excellent health. Their habits of living were the same; both were constantly subjected to the same climatic conditions; the only particular in which they differed was that the family which remained well took its water for domestic uses from a rain-water cistern, while the other obtained its water from a town well. Suspicion that the malarial diseases originated in the use of the well-water was thus aroused in the mind of Richard Lewis, M. D., now secretary of the North Carolina Board of Health, and, his subsequent investigations having converted suspicion into conviction, he has published his investigations and conclusions in *The Sanitarian* for December.

It has been thoroughly established that drinking-water may be the vehicle for conveying contagious diseases,—typhoid fever, cholera, etc.,—but malarial diseases have been usually ascribed to atmospheric conditions, as the word "malaria" itself indicates. While Dr. Lewis still admits this to be a common cause, he also maintains that water may be contaminated with the same poison, and cites many well-authenticated facts to sustain the view. The subject therefore has an important relation to city water-supply, and sounds a note of danger from a quarter hitherto unsuspected. The bulk of the paper is made up of accounts of cases of malarial diseases supposed to have originated in this way.

"As to the nature of the poison, many theories have been promulgated. Up to 1866 the universally accepted opinion was that it was gaseous in character. In that year Dr. Salisbury, of Cincinnati, O., announced the discovery of an alga, or small water-plant, which he assigned as the cause of malarial fever. While his conclusions were not generally accepted, inquiry on that line was stimulated, and from time to time various microscopic organisms were suggested as the cause, none of which, however, stood the test of experiment. But 'in 1881 Laveran claimed to have discovered in the blood of malarious subjects, in connection with the red corpuscles, rapidly moving filamented spherical organisms of about the same diameter as the corpuscles. . . . Many investigators who have followed in Laveran's track have corroborated his testimony, and hence there is a growing consensus of opinion that malaria is due to the introduction of *plasmodum malaria* into the system; that it attacks the red blood corpuscles, lives and grows within them, and finally disintegrates them,'—the explanation, by the way, of the familiar fact that the subjects of chronic malaria are always very pale and bloodless. Since the above was written (in 1892), favorable evidence has accumulated, and it is now generally believed that this little blood parasite—this microscopic vampire, so to speak—is the cause of this kind of disease."

That this poison is carried by water is so firmly believed by Dr. Lewis that he warns the public against the use of water from surface wells, and counsels the use of deep-

ored wells, or, when this is not practi-
ible, the employment of cisterns, which
e as good from a sanitary point of view,
ut not so reliable for uniform water sup-
ly.

But how about the water supplies of
rge cities, almost always collected from
e surface into reservoirs for storage?
Dr. Lewis is correct in his views,—and
ey seem to have been sustained by the
pinions of a great many North Carolina
hysicians expressed in reply to a circular
questing information,—it would seem
at cities should be more liable to this
ass of diseases than rural districts. But
is is not the case. Perhaps there may
some counteracting influence that, if
nown, would account for this; but, in the
bsence of such knowledge, the compara-
ve immunity of cities is a fact that seems
tell against the theory of transmission
malarial diseases by surface-water.

Capitalized Cost of Street-Grades.

A PAPER on " Street-Grades and Cross-
gs," by Mr. William B. Fuller, in *Jour-
al of the Association of Engineering Soci-
ies* (Nov.), presents the subject in a light
at will be new, at least to most laymen.
the proper determination of a street-
rade there are more things to consider
an is generally supposed by those not
tirely familiar with this kind of work;
d it may be reasonably inferred that in
ying out streets, as municipal work is or-
inarily conducted, some of these points
re often overlooked entirely.

"There is, first, the necessity of balan-
ing, as nearly as may be, the cuts and fills,
that the first cost may be low; next, the
onsideration of surface-drainage, in order
at the water may not be directed in ex-
ss to any one spot, or made to discharge
a dry run which may be obliterated by
ivate improvements, and thus force the
grading of the street or the building
an expensive drain; next, the grades
ould be so arranged as to do away
ith deep cuts for the sewers which
ay become necessary under the street
rface, and care should be taken that
e street surface is far enough above the
neral drainage level to provide proper
cellars. All of this, as well as the need of following the natural surface as nearly as may be, in order to reduce claims for drainages from abutting property owners, constitutes a study of what we may call the first cost of construction."

One of the points frequently lost sight of is the cost of maintaining the roadway after construction. That this has a direct relation to the established grade is clearly shown. The steeper the grade, the more will the surface be worn by the action of horses' hoofs, by the friction of the wheels when brakes are applied, and by "scour of water." "Another factor, and one of vital importance, is the cost of operation of a grade. This cost is a direct money loss, and one which increases with each year's increase of traffic and with each improvement of the road surface. Hence, a grade is properly determined only when the sum of the first cost, and of the capitalized cost of maintenance and of operation, is at a minimum, and should never be tolerated unless the capitalized extra cost of operation is less than the cost of changing to better conditions."

The cost of operating a grade depends, among other things, principally upon "the resistance to traffic on a level road. . . . ; the resistance directly due to the grade of the road . . . . ; the wear on harness, vehicle, and horse . . . . ; the effect of grade on time of travel . . . . ; and the difficulty of obtaining a foot-hold for horses on sloping surfaces." In the estimation of some of these factors of cost, there are minor factors that effect the final result; for instance, in estimating the resistance to traffic on a level road, the kind of vehicles to be used on it, the speed at which they are impelled, the material of which the road surface is made, and the average state of repair which will be maintained, all demand attention. Due consideration being given to all the elements which enter into the different factors in the cost of operating grades, Mr. Fuller evolves therefrom a general formula for what is appropriately styled the capitalized cost of grades. By the application of this formula accurate comparisons of cost can readily be made.

Engineers for Certain Public Offices.

Of the danger attending municipal control of any industry or engineering works, except those that provide for the supply of prime necessities of life,—such as potable water and drainage facilities,—an editorial in the *Engineering Record* for Dec. 15 is significant.

"At the present time, when the attention of appointing powers—no less than that of the public in general—is directed by recent political events of the better kind to the selection of candidates for public office on the score of fitness for the discharge of duties rather than capacity for politics, it is well to emphasize the correct meaning of 'fitness' for certain classes of official responsibility involving more or less engineering knowledge and experience. In every State, county, and city there are officials with whose functions the great mass of the people served are little or not at all acquainted in consequence of the technical character of the work they perform. It is only rational and barely consonant with a wise public policy that just in so far as the nature of such work is removed from common knowledge those who perform it should by their high professional and moral standing insure to the community at large faithful and efficient discharge of official responsibility. Abundant experience has shown that neither oath nor bond can be relied upon as a safeguard to take the place of a high professional reputation or efficiency attested by accomplished works. It is, or ought to be, superfluous to say that such a meritorious class of professional men do not usually seek offices, for the simple reason that private interests in the community seek them for the advantages accruing from their services."

The contrast between private business methods and those of municipal corporations in the selection of men to fill positions requiring expert qualifications is striking. In the one case the controlling factor is expertness in the functions to be performed, in the other it is political influence. Nor is there any immediate prospect that this can be changed. The history of the past shows that municipal governments are, to say the least, not getting better, even if, for the sake of argument, it be admitted that they are not getting worse. Much permanent improvement in the election of public officers in engineering departments of city works is not to be reasonably expected, so long as human nature remains what it is, and so long as political systems remain as imperfect as they are.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

*27170. Outdoor Lighting by the Incandescent Burner. F. G. Dexter, with Discussion (J G L–Nov. 20.) 4800 w.

*27508. Mr. Livesey on the Municipalization of Gas Supply (G W–Dec. 1.) 1200 w.

*27509. Inclined Retorts of the Leigh Gas Works. A. T. Fletcher, with Discussion (G W–Dec. 1.) 6000 w.

*27510. Prepayment Gas Meters. J. Nasmith (G W–Dec. 1.) 5500 w.

*27627. Prepayment Gas Meters as Sanitary Appliances (J G L–Dec. 4.) 2000 w.

27652. Gas as an Illuminant. Foree Bain (W. E–Dec. 15.) 900 w.

*27696. Thwaites Motor Gas Producer Plant (E R L–Dec. 7.) 1500 w.

27724. Benzole Carburetting Apparatus. Ill. (A M & I W–Dec. 14.) 1500 w.

27726. Ought the Guide Frame of a Multiple Lift Gas Holder Comprise the Upper Lift When Inflated to Full Capacity? A Discussion. David Leavitt Hough (P A–Dec. 15.) 2500 w.

27727. An Important Victory for the Welsbach Light.—Case of the Incandescent Gas Light Company vs. the Deimel Light Company, London (P A–Dec. 15.) 5500 w.

*27906. Improved Carburetted Water Gas Apparatus. Ill. (Inv–Dec. 15.) 2000 w.

*27997. A Small Experimental Plant as an Aid to the Management of a Coal Gas Plant. Peter Young (G W–Dec. 15.) 1400 w.

28077. Allen's Apparatus for the Manufacture of Gas. Ill. (A G L J–Dec. 31.) 2500 w.

*28126. Out-Door Lighting by the Incandescent Burner. F. G. Dexter (G E M–Dec. 10.) 1700 w.

*28127. Notes on Coin Meters. Frank Livesey (G E M–Dec. 10.) 1300 w.

28183. An Extensive Soft Coal Gas Apparatus. Ill. (P A–Jan. 1.) 1000 w.

28287. Liquid Fuel in Retort Houses. Ill. (A M & I W–Jan. 4.) 1600 w.

*28298. Radiometry and Photometry.—On the Work of H. O. Lummer and F. Kurlbaum (J G L–Dec. 25.) 1700 w.

*28299. Strains in Gasholder Guide Framing. M. Niemann (J G L–Dec. 25.) 900 w.

*28313. The Use of Flueless Stoves in Confined Rooms. Thomas Fletcher (G W–Dec. 29.) 900 w.

Sewage.

27601. Ventilating Subway Manholes by Sewer Connections. J. P. McQuaide (E R N Y–Dec. 12.) 600 w.

27829. Comparative Merits of Vitrified Pipe and Brick for Large Sewers (E N–Dec. 20.) 600 w.

28012. Sewer Construction in Boston, Mass. Ill. (E R–Dec. 22.) 2200 w.

28221. Test of Tightness of Cement Joints in Vitrified Pipe Sewers Made by Freeman C. Coffin. Ill. (E N–Jan. 3.) 3000 w.

Streets and Pavements.

27524. Roads and Carriages. Sterling Elliot (G R–Dec.) 7000 w.

27525. The Feasibility of McAdam Roads in Prairie Country. Horace G. Kauffman (G R–Dec.) 2300 w.

*27788. Street Grades and Intersections. William B. Fuller (J A E S–Nov.) 2000 w.

27822. Costs of Macadamizing Streets at Burlington, Vt. (E N–Dec. 20.) 2000 w.

*28195. The Benefits of Street Paving. George W. Shanklin (P–Jan.) 3000 w.

*28196. Highway Improvement in Massachusetts. Ill. Burton H. Allbee (P–Jan.) 1800 w.

28219. Portland Cement Pavements. G. W. Bartholomew, Jr. (E N–Jan. 3.) 800 w.

*28326. Street Paving and Hygiene. Editorial (Eng L–Dec. 28.) 2000 w.

Water Supply.

27505. Water-Pipe Repairs, St. John, N B. (E R–Dec. 8.) 1000 w.

*27579. The Water Supply of Towns (B–Dec. 1.) 2500 w.

27607. The Toronto and Hamilton Power and Water Supply Aqueducts—Are they Feasible Schemes? J. H. Killey (C Eng–Dec.) 1500 w.

27717. Steel Conduit Repairs, Toronto, Ont. Ill. (E R–Dec. 15.) 1600 w.

*27993. Water Purifying and Softening. (Abstract.) E. Brough Taylor (I C B–Dec. 14.) 1800 w.

28011. The Queen Lane Reservoir (E R–Dec. 22.) 4000 w.

28047.—75 cts. Experiment with Tube Wells at Lowell, Mass. George Bowers (J N E W–Dec.) 4200 w.

28048.—75 cts. What a Water Supply Engineer Can Do in the Fire Department. James E. Tryon (J N E W–Dec.) 4000 w.

28049.—75 cts. Notes on European Water Supplies. Allen Hazen, with Discussion (J N E W–Dec.) 8000 w.

28180. Changing the Suction System of a Pumping Engine. F. W. Dean. Read before A. S. M. E. (A M–Jan. 3.) 600 w.

28185.—$1.50. The Dunning's Dam, near Scranton, Pa. Ill. E. Sherman Gould, with Discussion (T C E–Nov.) 11500 w.

28264. Specifications for Riveted Steel Pipe, Cambridge, Mass. L. M. Hastings (E R–Jan. 5.) 1800 w.

Miscellany.

*27456. Municipal Cleansing and Public Health. George E. Waring, Jr. (E Mag–Feb.) 3000 w.

*27457. The Relations of Railways to Municipalities. Dwight Arven Jones (E Mag–Feb.) 3000 w.

27725. Tests of Building and Paving Bricks, with Editorial (E N–Dec. 13.) 2700 w.

27735. Engineers for Certain Public Offices. Editorial (E R–Dec. 15.) 800 w.

27824. The McKay Garbage Crematory at Yonkers, N. Y. Ill. (E N–Dec. 20.) 750 w.

27826. The Wrong Way to Conduct City Engineering (E N–Dec. 20.) 1500 w.

*27964. Sanitary Wash House at Glasgow. Ill. (E–Dec. 14.) 2300w.

28015. An Italian Public Wash-House. Ill. (E R–Dec. 22.) 900 w.

*28134. Old London Streets and Houses (A L–Dec. 21.) 1800 w.

28354. Parks and Park-planting. Editorial (G & F–Jan. 9.) 1600 w.

Serials.

23641. Details of Rural Water Supply (B–Began July 7—Ended Dec. 29—26 parts—30 cts. each).

24338. The Gas Engine (P A–Began Sept. 15—5 parts to date—15 cts. each).

24751. The Gas Manager Abroad (G W–Began Aug. 25—11 parts to date—30 cts. each).

26096. Notes on Modern Gas Making Plant (I & I–Began Oct. 12—Ended Dec. 7—6 parts—30 cts. each).

26221. The Manchester Thirlmere Water-Works. Ill. (Eng L–Began Oct. 19—3 parts to date—30 cts. each).

27272. The Construction of the New Syracuse Water Works. Ill. (E R–Began Dec 1—4 parts to date—15 cts. each).

27636. The Economic Principles of the Gas Producer (M W–Began Dec. 7—2 parts to date—30 cts. each).

27723. Gas-Holders. Ill. Herr Professor Pfeiffer (A M & I W–Began Dec. 14—Ended Dec. 28—3 parts—15 cts. each).

28028. The Report of the Dutch Committee on Photometry (J G L–Began Dec. 18—Ended Dec. 25—2 parts—30 cts. each).

28265. Frontinus on the Water Supply of Rome, A. D. 97 (E R–Began Jan. 5—1 part to date—15 cts).

RAILROADING

State Subsidies to Light Railways.

PROBABLY the reason for a more extended use of light railways in France than has yet been obtained in England is the fact that they have been helped by subsidies. *Transport*, quoting and translating from the *Voie Ferrée*, gives an account of the various forms of subsidies which have been adopted.

In one method, after "the lines are laid out and the cost estimated by the county engineers, this cost is estimated both per kilometer and for the entire line. The department, with the help of the State subsidy, makes itself responsible for the greater part of the expense. The companies who are inclined to bid for the concession examine the estimates and plans of the engineers, make their own calculations, and put in a tender in which they undertake: (1) To build the lines either for a price per kilometer, or for a lump sum which they put into their tender. In other words, they undertake to do the work at a certain discount off the price as estimated by the county engineer. (2) They offer to work at a certain price, which they also put into their tender in the form of a lump sum per kilometer, plus a definite percentage of the gross receipts."

The latter system is not approved. "Too often the department decides, not according to the business or financial capacity of the tenderers or their reputation, but according to the economies which it expects to make later on in the working expenses, —economies which probably will never be realized in practice. . . . Under this system the tenderers may very likely themselves be in error as to the probable earnings, and may undertake to do the work too cheaply, and it is quite likely that later on a working company will be compelled to abandon the undertaking to the very great injury of the department."

Another system—considered the best adopted up to the present time—is outlined as follows: "The construction costs are estimated by engineers as exactly as possible, and with the help of a schedule of prices, which takes a liberal view of the cost and of the interest of the constructing company. The company executes the works under the control of the county engineers on a schedule of prices, but with a fixed maximum for the line or lines included in the concession. The object of fixing a maximum sum is this: the accounts are settled after measuring up the work actually executed and charging them out at the schedule rates. If the result so arrived at is less than the fixed maximum, one-third of the difference goes to the department and the remaining two-thirds to the constructing company. If, on the other hand, the maximum is exceeded, the entire loss falls upon the company. In contracts drawn after this model, the department undertakes to bear the entire capital expense, and, in order to deter contractors or contracting companies who are untrustworthy, or with insufficient capital, from tendering, it has recourse to the following expedient: only three-quarters of the total expense are paid straight out; the remaining quarter is advanced by the contractor, and is either held as caution money or employed straight away on the works, being only paid by the department to the contracting company at the end of the concession. But during the whole time of the concession it bears interest at the rate of four per cent. The working company works at its own cost and risk. There is a fixed maximum for working expenses laid down in the concession. If this maximum is not attained, the working company receives as a premium two-thirds of the difference between the maximum and the actual expenditure. If the gross receipts are inferior to the maximum laid down for working expenses, the deficiency is carried to a suspense account. If the receipts are larger than the expenses, the balance is, in the first place, devoted to paying the deficiencies carried to suspense account, with interest at four per cent., and, after this has been done, is divided equally between the department and the working company. This system has been adopted by two light railways recently sanctioned in the Department of the Loire. In that case the actual figures were as follows: As long as the receipts are less than three thousand francs per kilometer, the maximum for working expenses is fixed at the same figure. When the receipts exceed three thousand francs per kilometer, the maximum is fixed by the following formula:—

$W = 1450 \text{ fr.} + 0.02\,T + 0.20\,K + 0.30\,R.$

"In this formula W is working expenses, 1450 francs is the fixed payment per kilometer per annum, the third, 20 centimes per train kilometer, and the last item the percentage of the gross receipts less rates and taxes."

Certain precautions needed in any system of subsidizing are pointed out. Among these are guarding against an overestimate of earnings, making the railway as far as possible a high road, working it with the strictest economy, and avoiding a greater number of trains than the traffic imperatively calls for. The economic effect of subsidies upon the general welfare of a commonwealth is not discussed in its broader aspects; but, if the extension of light railways in agricultural districts requires this sort of aid, the advantages of the system are questionable.

Past and Present of Car-Ventilation.

In line with what has been said about car-lighting, so far as it relates to the comfort and health of passengers, may appropriately be mentioned the subject of car-ventilation. Perhaps none of the minor problems of railroading have more obstinately resisted a satisfactory solution than this. One of the bottom difficulties is that there are always so many to satisfy, and, unless the progress of railway development evolves a kind of railway car wherein each passenger may travel by himself, and provided with means whereby he can breathe reasonably pure air or air mixed with as much carbonic acid as suits his individual taste, probably nobody will ever be satisfied with car-ventilation except theorists and visionaries. *Locomotive Engineering* for December editorially recalls the fact that "about twenty years ago the men representing the railroad car departments attempted to settle for all time the all exciting question of car-ventilation. That was a subject which had been familiar to railroad men ever since one passenger proceeded to open a car window while another person was protesting that the car was too cold already." About the time named there was a great deal said and done about car-ventilation, at least nine-tenths of which was waste effort.

"The Master Car Builders' Association was made the leading medium for exploiting the agitation. Elaborate reports were submitted to three successive conventions, and the whole subject was discussed from A to Z, and several times over again. The subject was discussed from the standpoint of the practical man, the scientist, the man who wants to be let alone in unhygienic comfort, and of the crank who insists that it is better to die of pneumonia than to violate nature's laws of cleanliness. There were learned opinions submitted concerning the nature of gases that contaminate the atmosphere of badly ventilated cars. The dreadful exhalations that exude from a crowded passenger car and the fearful disease germs that are disseminated when air is not circulated rapidly enough were pictured in a terror-inspiring manner. As the discussion waxed hot, the wonder grew that any person ever survived the ordeal of riding for a night in a badly ventilated car. Working in a sewer appeared a healthy occupation by comparison."

No wonder this cultivation of a field naturally fruitful produced a plentiful crop of ardently enthusiastic inventors, each of whom had not only the thing, but the very best thing needed to satisfy all parties. None of these things were difficult to manage; the only reason for not adopting them was purely and simply the parsimoniousness of railway managers, who, according to the unanimous testimony of all disappointed inventors, have never been known to adopt any improvement unless compelled to do so by the pressure of public opinion.

"We cannot estimate the number of patented car-ventilators which were permitted to enjoy a brief popularity or were applied to cars on account of this agitation for fresh air, but there were a great many of them. The world notes not how the agitation died down, but it came quietly to an end, and the average car was not disturbed with improved ventilators. The clere-story sashes and the windows were still there, and those in charge waited till the clouds of reform rolled by, and they rolled without making many permanent changes."

Recently two long papers on car-ventilation were read at the New England Railroad Club. It is said that the gentlemen presenting their papers each had inventions in this line wherewith to solve the difficulties. The discussion called out by the papers occupied a good deal of time. The difference in the tone of discussion from that of the former boom period in car-ventilation is noticeable. "Then the speakers were noted for the positive views expressed as to how the thing should be done. There was no uncertainty about how the work should be carried out. Every man was positive that he knew all about car-ventilation. The only striking difference that we noted after a lapse of twenty years was that all the speakers not interested in a particular invention were extremely non-committal, some even going to the extent of admitting that they did not know anything about car-ventilation. To judge by this, our progress has been merely in the direction of letting people understand how difficult it is to change the air in a car quickly and regularly, and at the same time keep the inside warm enough to prevent people from catching cold."

No one yet has been able to show how a car can be thoroughly ventilated and warmed simultaneously without drafts and other objectionable features. The same would be true of a room in any building no larger than can be allowed for a passenger car, and which an equal number of people were compelled to occupy for hours together. The entrance of dust with air currents into cars may be overcome. When this is done, the two cases would be exactly parallel.

Improvement of Block Working.

Mr. C. C. Anthony, in *The Railroad Gazette*, again calls attention to the fact that the "common American telegraph block system is not all the English block system, as it is often carelessly called; that the English system (aside from the Sykes) includes electric block instruments, which provides visible indications of 'line clear' and 'line blocked,' in addition to the information exchanged by the means of the electric bells. These indicators steadily exhibit the state of the road after permission has been given for a train to enter the block and while a train is in the block; at any moment information may be obtained from them at a glance. Indeed, they doubtless obtrude the information, and may be regarded as a silent and effective protest against errors that the signalman at either end of the block might make through forgetfulness, neglect to record certain movements, or failure to refer to his record before acting.

"The usual American arrangement of simple communication by bells or telegraph differs, then, distinctly from the English in the absence of these visual block indicators. But although the employment of such instruments on many American roads now using telegraph block would undoubtedly increase the efficacy of the block working, the same thing that stands in the way of the controlled manual system would come in here. Many roads that can gain much in safety by using the telegraph already at hand for block working could not, on account of the cost, provide an equipment of block instruments. In looking, however, for means of bettering the telegraph block, while too much can hardly be said of the need of thorough instruction and careful oversight of signalmen, another important difference between the American and the English should be oted. The difference already noted is ne of appliances. But more than that, ie safety of block working in England greatly enhanced by the use of carefully :udied codes of rules and bell signals. 'ot only do some of the well-known lines ave such codes, the equal of which would robably be found on few American lines, ut already standard codes have been preared. It may be imagined, however, that lock working is rather a simple matter. .pparently a code of signals for commuication between towers or stations could e written off in a few minutes. It would e easy enough to set down some numers to be rung on the bells and to write pposite the numbers the information it hould give; or a few abbreviations or umerical symbols could be provided for ie telegraph. And as for the rules, the iain thing is that a man should not admit train to the block unless he knows that he block is clear, or until he has got the ermission of the next man ahead; a few imple rules and instructions would be ufficient. Easy enough, surely. But vhen it is attempted to carry on block vorking with strictness and to provide for ome of the many contingencies that contantly arise,—such as trains crossing over r going into or out of sidings, trains roken in two, trains without markers, rains backing into blocks, trains coupled ogether, and so on,—the simplicity of the vork disappears. Indeed, a considerable xperience on a road largely equipped vith the Sykes system may justify the asertion that both the right arrangement of he bell or telegraph code and the provion of full and clear instructions are highly mportant." Improvements in signal codes re suggested, and the opinion advanced nd seemingly justified that efficiency of lock working on many American roads night be increased, without a materially ppreciable increase of cost, by "improveient and enlargement of the codes of ules and signals for communication beween block stations." The English odes are recommended as models from hich suggestions of improvement may e derived for existing American codes, ot yet worked out to perfection.

Railway Ties.

DISCUSSING "The Proper Length of Railway Ties," Mr. Jerry Sullivan, in the *Railway Review* (Dec. 8), finds it difficult to fix upon the origin of the standard 4 ft. 8½ in. railway gage, but seems to think it probable that "the original promoters of the railway adopted this gage in order to enable them to make use of the old Concord coaches or stages as passenger cars." However this may be, this gage has been found practicable and serviceable, and, unless some new and unexpected development in railway practice shall arise, the present standard gage is not likely to be departed from. Too many vested interests oppose any change, even if a change could be shown to be to some extent advantageous, which, in view of former experiments both with wide and narrow gages, is not probable.

The present length of ties—eight feet—does not seem so "immutably fixed." It is considered as "having been largely a matter of evolution, and, as it is asserted that the present length 'does not fully meet requirements,' this is considered a sufficient basis for supposing a change at some time in the near future may be demanded. A careful scrutiny as to the effect of passing trains on some railway track will disclose that each wheel of a passing train depresses the ends of the ties from one-fourth to one-half inch, depending on the size of the tie and the weight it supports. In order to be sure that this wavy motion does not come from the ballast, the observer may look under the ties after the train has passed, and it will be found that in no case do the ends touch the ground. This shows, of course, that the greater portion of the weight of trains is borne by a small ridge of ballast under the middle of the ties, and that the ballast under and outside of the rails affords a support only when the flexibility of the ties permits them to bend down far enough to rest on this ballast. This is known as a center-bound track, and is very destructive to ties, breaking them at their weakest point between the rails."

Swings and sags are also effects of a center-bound track. "These are primarily caused by a weak spot in the ballast, or by several ties being laid together with the small ends all one way; and, the rail becoming low at this point, the cars tip sideways, and by their rebounding throw extra weight on the opposite rail, thirty to fifty feet further on, thus producing a series of low places alternately on each rail, making a very rough track." A remedy proposed and advised for this—an untamped strip of ballast midwise between the rails—is "about as bad as the disease, because during the rainy season untamped space under the center of the ties is liable to become filled with water, softening the roadbed and doing great damage to the track. So the trackmen are left to take either horn of the dilemma they please. If they tamp the center, the ends of the ties will work up and down under every passing wheel, like the rhythmic motion of piano keys under an adept's fingers; only, instead of discoursing sweet sounds, they belch forth a disgusting medley of mud, slush, and slime; while, if they do not tamp the centers, the mud will be found there."

From this it is argued that the ties ought to be of such a length as to support the same weight on the outside as on the inside of the rail; and, in order to effect this, the ties will need to be lengthened to ten feet, which would give a more stable track and require a less number of men for track service. The fact that such increase of length would practically increase by twenty-five per cent. one of the heaviest items in track maintenance is not mentioned. It is, however, asserted that the 8-ft. tie is not now giving satisfaction, and that increase in weight and speed of trains must soon compel a change in this detail of railway construction.

Franchises.

STARTING with the assumption that much confusion with reference to franchises exists in the minds of the public, Mr. R. D. Fisher in the *Street Railway Gazette* (Dec. 1) assigns as a reason for this lack of accurate conception, "a failure to keep pace with the law of corporations." Chief Justice Taney's definition of a franchise is quoted: "Franchises are special privileges conferred by government upon individuals, and which do not belong to the citizens of the country or community generally of common right. It is essential to the character of a franchise that it should be a grant from the sovereign authority, and in this country no franchise can be held which is not derived from a law of the State." Exclusive privileges thus granted are usually the inducement for men to organize corporations affording traveling and transportation facilities to the public. The vast network of American railways has been built by such corporations, working under such privileges, and—of scarcely less importance—the street railways for local traffic have been built in the same way. The instrument that shows such special privileges have been granted to a corporation is called a "charter." A privilege granted by a municipality, as, for instance, permission to a street-railway company to lay tracks in certain streets, is not a charter; it is a license; yet it is often in popular thought confused with the idea of a charter. In law the two things are of quite different effect, though each grants a privilege.

The only interest a street railway acquires in a street by reason of its franchise is "right of way," and this also has been, and its rights are, limited to the specific purpose for which the franchise or license or both is granted. "A license is simply a permission to do certain things. Hence a license or permission to occupy a street is not 'a special privilege or immunity' within the meaning of constitutional inhibitions. (See 31 Kan., 660, and Booth on Street Railways, 11.)" The question of most interest to the general public as regards street-railway franchises is what kind of streets or property is exempt from use by street-railway corporations, or subject to grant for this purpose. On this point it is asserted that the "consent by the State or municipal anthorities to occupy public highways for the construction, maintenance, and use of ordinary street railways is all that is necessary, and this, too, without compensation to abutting property owners. The recent decisions firmly uphold this doctrine of non-additional servitude. There is some conflict of opinion whether or not one company may appropriate the use of the right of way and tracks previously acquired and constructed by another; the weight of authority, however, is to the effect that such property may be taken."

A subject out of which much litigation has grown is the life of franchises. Of course a franchise may be limited by its own terms; but, when no limitation has been expressly stipulated or implied, it has been assumed that the franchise is perpetual. Most of the States have constitutionally inhibited the enactment of laws providing for the grant of irrevocable franchises; but, in the absence of these, "it is safe to assume that a State legislature may grant privileges exclusive in character and perpetual in duration; but a city has no such power without explicit legislative authority."

Mr. Fisher has compiled a list of street railways in the United States operating either under perpetual licenses or under very long terms, and they are more numerous than is generally supposed. Thirty-seven different roads are included in this list.

The Railway Year in Queensland.

"TRANSPORT" (Nov. 2) says that Queensland has suffered more from the recent commercial depression than any other colony in Australia. "Times have been bad in Melbourne, Sydney, and Adelaide, but colonists generally are agreed that in Brisbane they have been worse than anywhere. The colony had its boom, just as some of the others had, and over-speculation and commercial gambling on a gigantic scale did their work. The inevitable reaction set in, the more reckless of the adventurers went to the wall; and the more unstable of the trading concerns were swept out of existence; but, just as the commercial atmosphere was being purified, then came the disastrous floods, overwhelming the entire community in practical ruin."

It is significant of the strong character of the men who have peopled the colony that the government, banking institutions, and business men were able to bravely meet such a complication of disaster, and that "by the introduction of large and sweeping economies Brisbane has been able to keep its head above water."

Of course railway traffic took its share of this bitter medicine, and "the year's record, as a matter of fact, is discouraging." Some peculiar concomitants of railway operations in the Australian colonies are indicated in the following extract from the official report of the Railway Commissioners:

"We much regret that the 'Railway Border Tax Act' of 1893, which came into force on the 21st of July, 1893, has not had the effect of diverting to our lines the traffic from competitive areas in the south-western districts of the colony to the extent expected, notwithstanding the fact that we have considerably reduced the rates to a large number of the holdings. Two causes have operated against attaining the object in view. The carriers (teamsters and drivers of camel caravans) have largely reduced their rates for carriage to the New South Wales lines, and the New South Wales commissioners have followed their example."

Camel caravans as feeders of traffic to railway lines will seem strange to American readers. "Commissioners believe that the true solution of the difficulty will be found in the extension of the line from Charleville. This, it is thought, not only will secure to Queensland nearly the whole of the traffic which is now carried through New South Wales and South Australia, but will tend to develop the pastoral areas, and thus increase the traffic over existing lines. The frozen meat industry has not developed to the extent expected when the last report was issued, owing to the difficulty which has been experienced in obtaining steamers fitted with the necessary appliances for its conveyance, and partly owing to the fitful condition of the market in England for the commodity itself. Negotiations were being conducted in London by representatives of the freezing works in the colony with the view of regulating the supply and promoting the demand."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

RAILROADING.

25956. Street Railway Repairs. J. B. Cahoon (E W–Oct. 20.) 5000 w.

*26680. The Railway Year in Queensland (Tr–Nov. 2.) 1800 w.

27255. Franchises. R. D. Fisher (S R G–Dec. 1.) 2000 w.

*27270. Traction Engines. Editorial (Eng L–Nov. 23.) 1400 w.

*27284. The Past and Present of Car Ventilation (L E–Dec.) 1100 w.

*27455. The Railroad of the Future.—A Forecast of Coming Improvements. Theodore Voorhees (E Mag–Feb.) 3000 w.

*27457. The Relations of Railways to Municipalities. Dwight Arven Jones (E Mag–Feb.) 3000 w.

*27479. The Glasgow District Subway. Ill. (R W–Dec.) 5000 w.

*27480. The Congo State Railway. Ill. H. Conradi (R W–Dec.) 2000 w.

*27481. The Greathead Tunnel System Abroad (R W–Dec.) 1200 w.

*27482. A Sketch of Fare Checking (R W–Dec.) 3000 w.

*27483. Mail, Goods and Parcel Service on Tramways (R W-Dec.) 2000 w.

*27485. De Rechter's Radial Suspension for Railway Carriages and Tramcars. Ill. (Eng L–Nov. 30.) 1300 w.

*27490. Locomotives and Trains. Editorial (Eng L–Nov. 30.) 2000 w.

27597. The Proper Length of Railway Ties. Jerry Sullivan (R R–Dec. 8.) 1100 w.

27604. Car Construction and Decoration. Ill. Works of St. Charles Car Company (R C J–Dec.) 700 w.

27621. The Baltimore Belt Railroad. Ill. (R G–Dec. 14.) 2700 w.

27622. Annual Report of the Interstate Commerce Commission (R G–Dec. 14.) 3000 w.

27646.—75 cts. State Railways in Australia. William Hill (J P E–Dec.) 8000 w.

27649.—75 cts. State Aid to Railroads in Missouri. John Wilson Million (J P E–Dec.) 7500 w.

*27687. South Wales Railway and Dock Bills (Eng L–Dec. 7.) 2000 w.

27721. The National Disgrace of Train Robberies. Editorial (R A–Dec. 14.) 1500 w.

27738. A Modern Coal Handling Plant.—Lehigh Valley Coal Company. Ill. (R R–De 15.) 1000 w.

27740. Income Account of Railways in the United States (R R–Dec. 15.) 600 w.

27741. Grade Reductions. Editorial (R R–Dec. 15.) 1100 w.

27742. The Desirability of Freedom from Restriction in the Use of Box Cars (R R–Dec. 15.) 1000 w.

*27745. Light Railways—The Conference at the Board of Trade (Ry T–Dec. 8.) 14000 w.

*27786. Notes on the Brooklyn Elevated Railway of Brooklyn, N. Y. Ill. A. A. Stuart (J A E S–Nov.) 2700 w.

27827. Car Lighting by Storage Batteries in the Chesapeake and Ohio Railway (E N–Dec. 20.) 1400 w.

27835. The Physical Condition of Atchison (R G–Dec. 21.) 2800 w.

27836. The Decision in the Debs Case, with Editorial (R G–Dec 21.) 3000 w.

27837. The Street Railroads of New York. Ill. (R G–Dec. 21.) 2500 w.

27839. The Traffic Managers Doings in 1894 (R G–Dec. 21.) 1500 w.

27840. The Accident in the Chicago Cable Tunnel (R G–Dec 21.) 900 w.

*27849. Cast-Welding Rail Joints—A Promising Rival of Electric Welding. Ill. (S R R–Dec.) 1800 w.

*27851. Personal Injury Accidents—The Management of Employés, with Reference Thereto. By a Superintendent (S R R–Dec.) 2500 w.

*27852. The Model Plant of the Fairhaven and Westville Railroad, New Haven, Conn. (S R R–Dec.) 900 w.

27900. Prussian Railway Reform. H. K. White (R R–Dec. 22.) 1200 w.

27901. Continuous Rails by Cast Welding. Ill. (R R–Dec. 22.) 1200 w.

27903. Railway Manufacturing. Editorial (R R–Dec. 22.) 1200 w.

27904. The Right to Route Passengers. Editorial (R R–Dec. 22.) 900 w.

27930. Rapid Transit. C. Wellman Parks (E W–Dec. 29.) 1000 w.

27936. The A. R. U. Leaders Found Guilty. Decision of Judge Woods in the Contempt Case Against E. V. Debs and Associates (R A–Dec. 21.) 4000 w.

*27944. American Railway Securities in Germany (B T J–Dec.) 1500 w.

*27951. Great City Railroads. Robert I. Sloan (Ch–Jan.) 3500 w.

*27960. Express Locomotives for Liquid Fuel. Ill. (E–Dec. 14.) 2200 w.

*27961. Light Railways. Editorial (E–Dec. 14.) 3800 w.

*27967. "Eighty-Four Miles an Hour." Charles Rous-Marten (Eng L–Dec. 14.) 5000 w.

28044. The Latest Plan for a New York Rapid Transit Railway. Ill. (E N–Dec. 27.) 1400 w.

*28062. The Prospects of Electric Traction (E E L–Dec. 21.) 2300 w.

*28100. Electric Traction.—Discussion of ers Read Before the Institution of Electrical gineers (E–Dec. 21.) 3000 w.

8125. Engineer Parsons' $66,000,000 Rapid ansit Plan for New York City (E R N Y–Jan. 900 w.

8137. The Harper's Ferry Improvement of Baltimore and Ohio Road. Ill. (R A–Dec.) 1000 w.

*28138. Block Signaling. Ill. W. H. Elliott E–Jan.) 2000 w.

*28139. Railway Machinery in Great Brit- . Ill. A. S. (L E–Jan.) 1600 w.

*28141. Edison Car Shops. Ill. (L E–Jan.) 0 w.

8161. Tunneling under London.—The terloo and City Electric Railway. Ill. (E Y–Jan. 2.) 800 w.

8167. The New Compound Locomotives of Paris-Lyon-Mediterranean Railway. Ill. . Baudry (R R–Dec. 29.) 1000 w.

8168. Reasonable Railway Rates. H. T. wcomb, with Editorial (R R–Dec. 29.) 0 w.

8169. Operation of Railroad Stock Yards. itorial (R R–Dec. 29.) 900 w.

8170. The Right to Collect Excessive Back arges. Editorial (R R–Dec. 29.) 1400 w.

8186.—$1.50. Railroad Signaling.—The ck System. Ill. John P. O'Donnell, with scussion (T C E–Nov.) 22000 w.

28199. The System of the People's Traction mpany, Philadelphia. Ill. (S R J–Jan.) 0 w.

28200. Double Truck vs. Single Truck s. Ill. John A. Brill (S R J–Jan.) 2200 w.

28201. Street Railway Wheel Flanges. Ill. R J–Jan.) 1500 w.

28202. The Perfect Wheel (S R J–Jan.) 0 w.

28203 Behavior of Wheels on Rails (S R an.) 2000 w.

28204. Street Railway Experience in Den- . Ill. C. K. Durbin (S R J–Jan.) 2000 w.

28205. The New Power Station of the Con- idated Traction Company of New Jersey. (S R J–Jan.) 1200 w.

28206 Rails and Special Work; Their thod of Manufacture. Ill. (S R J–Jan.) 0 w.

28209. The Pennsylvania Railroad's Co- bian Exhibit. Ill. (N C B–Jan.) 1000 w.

8217. Track Laying by Machinery, with itorial (E N–Jan. 3.) 4500 w.

8218. Some Recent Fenders for Street Cars. (E N–Jan. 3.) 800 w.

8220. The Latest Decision in Air-Brake ent Litigation (E N–Jan. 3.) 1500 w.

8248. The Hungarian Railroads. (Abstract.) E. Ziffer (R G–Jan. 4.) 1000 w.

8249. Compressed Air in Railroad Shops. F. M. Wilder (R G–Jan. 4.) 1300 w.

8250. Employees' Tickets in England. C. G. (R G–Jan. 4.) 1100 w.

28260. The New Power Station of the Lindell Railway Company, St. Louis. Ill. (W E–Jan. 5.) 2000 w.

28262. Transporting and Handling a Sixty Ton Cable. Ill. (E R–Jan. 5.) 2500 w.

28275. The Electric Street Railway Car Controller. Anon. (E W–Jan. 5.) 1200 w.

28279. About Specifications—Shall They Be Strict or Lax? Editorial (R E M–Jan.) 800 w.

28302. The Relation of Railways to Industrial Prosperity. W. C. Brown, with Editorial (R R–Jan. 5.) 4800 w.

28303. The History of the "Bogie Truck" as Applied to Locomotives. Clement E. Stratton (R R–Jan. 5.) 1500 w.

*28323. The Railways of New South Wales. C. (Eng L–Dec. 28.) 2000 w.

*28327. The Meigs Elevated Railway System. Ill. (Eng L–Dec. 28.) 2500 w.

28335. European Street Railways—From the N. Y. Sun (S R G–Jan. 5.) 1600 w.

28363. Electric Railway Development in Northern Ohio.—The Street Railway Systems of Cleveland and Vicinity (E R N Y–Jan 9.) 1200 w.

Serials.

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M–Began Dec. 1893—12 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M–Began Jan., 1894—9 parts to date—15 cts. each).

24586. Railway Companies and Their Employés (R A–Began Aug. 24—7 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R–Began Aug. 25—19 parts to date—15 cts. each).

25670. Special Shop Tools. Ill. (R E M–Began Oct.—4 parts to date—15 cts. each).

26400. Railroad Legislation and National Prosperity. Don Alexander (R G–Began Nov. 2—3 parts to date—15 cts. each).

27091. The Manchester and Sheffield Railway Extension to London. Ill. (E–Began Nov. 16—Ended Dec. 21—3 parts—30 cts. each).

27364. State Subsidies to Light Railways (Tr–Began Nov. 23—2 parts to date—30 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. A. Flamanche, A. Huberti and A. Stewart (R C J–Began Dec.—1 part to date—15 cts).

27850. What Street Railways Can Learn from Steam Roads. Ill. (S R R–Began Dec.—1 part to date—30 cts).

27905. The Electric Braking of Motor Cars. Ill. W. Nelson Smith (S R G–Began Dec. 22—Ended Dec. 29—2 parts—15 cts. each).

28101. Light Railways. J. Walwyn White (E–Began Dec. 21—Ended Dec. 28—2 parts—30 cts. each).

28304. Signals and Signaling. Anon. Ill. (R R–Began Jan. 5—1 part to date—15 cts).

SCIENTIFIC MISCELLANY

Peach Culture in Belgium.

The *Journal of the Society of Arts* has printed an interesting article on the culture of peaches in Belgium, which draws largely from a recent report of the U. S. Consul at Liege for its facts, and which demonstrates the importance, now thoroughly recognized in scientific horticulture, of the practice of budding a variety of fruit trees upon a more hardy and a vigorous stock of kindred tree, thus enabling the weaker scion to be successfully grown where otherwise nothing but failure could be expected. The facts with reference to the practice are not in themselves new to horticulturists, or unfamiliar to American readers of horticultural papers. The principle is extensively practised in ornamental and landscape gardening. For example, some varieties of roses are obtained in much greater perfection through budding them upon hardier stock than would be possible were the parent stock alone relied upon. The results attained in Belgium in the growth of peaches, by the use of this method, showing how far it can be carried, and how profitable it can be made, together with methods of preventing injury by frost, are interesting. After supplying a population of 500 to the square mile, Belgium annually exports about 105,000,000 pounds of fruit, the value of which is $2,904,000, a large proportion of this exportation being peaches. What is remarkable about this is that seedling peaches grow and produce very feebly in Belgium.

"In fine soil and in situations protected from the north and north-east winds, peach trees grown from the seed have occasionally borne fruit; but, to ascertain the best stock upon which to bud, a long series of experiments were tried upon all the varieties of prune, apricot, sweet and bitter almonds—every tree, indeed, of a kindred nature—till the conclusion was reached that the best stem for grafting was the red plum. This hardy plant, whose roots spread wide and strike deep, imparts much of its own vitality to its foster scions. Grafting or budding is done out of doors, so as not to soften the young tree by accustoming it to unnatural conditions. The next question to be considered was that of soil. In sandy and dry earth it was found that neither the tree or the fruit flourished, the one being spindling and the other small; while in rich and moist alluvial soil the tree prospered at the expense of the fruit. A calcareous soil, neither wet or dry, is preferred by the peach, the young trees requiring a great deal of lime. As it is impossible to tell, without chemical analysis, the exact amount of this element contained in any given quantity of earth, its application must be more or less experimental. The rule in Belgium is to first thoroughly fertilize the soil with manure, and then, after planting the tree, to add a peck of lime to every cubic yard of earth, placing it near the surface. As it is necessary to loosen the earth for at least 6 feet square and 3 feet deep, this quantity —a bushel to a tree—may seem large, but the authorities are all agreed that more rather than less would be better. The application should be repeated every three years."

The method of espalier culture has succeeded better than the standard trees, but the sunny sides of walls and buildings are now preferred. Peach trees with dwarf stems not more than twelve inches high, and with branches six feet long, spreading fan-like over an extent of southern wall, and loaded with fruit, are one of the commonest sights in Belgium. The prolific growth of fruit thus attained is astonishing. On four of these dwarf trees growing on a surface of about 30 feet square, 2300 good-sized peaches were counted. The modes of protecting these growths from frost, to which they are much exposed at the time of flowering, are the placing among the upper boughs of the tree branches cut from other trees; or, what is less generally preferred and practised, the overing of the trees with mosquito neting, which, while it admits light and air, ias proved a sufficient protection. With eference to the rationale of these methods, he object of either of them is to retard he flowering till such a time as the buds nay open with safety from injury by frost; nd it is added that the method must be ised with caution, as too much shade is pt to injure the germs by excluding the ays of the sun.

"The old custom of using closely-woven loth, like table or bed linen at night, and emoving it in the morning, is said to be nore dangerous than the frost itself, as the rees at this season cannot be deprived of ir without serious injury. In addition, his artificial heat at night, succeeded by he warmth of the sun, hastens their blowng, when the object is to delay it as long s possible. Shading at night is someimes as essential as covering at night. he poor succeed very well in protecting heir fruit by placing a number of horiontal poles about 18 inches apart, and rom 4 to 6 inches from the trees, and covring them with light wisps of straw. In ood situations, penthouses will sometimes uffice to protect the fruit; in any case hey are extremely useful in checking the low of sap. Since 1876, the following adlition to this method has made assurance loubly sure: A fringe, made of unthreshed ye straw by tying the cut ends of the talk together with twine or cord, six or ight in a loop, with spaces of about 3 nches between the wisps, is attached to a ole and suspended under the eaves of the enthouse and in front of the trees. The exture being open, it does not prevent he light and air from reaching the buds. These shields are usually placed in posiion about the 1st of March, and are not renoved except in cloudy weather, until all langer has passed."

These facts are suggestive to American iorticulturists of the amateur sort. In this ountry the culture of the peach has mirated, the tendency being toward milder limates. The results are an increase in ize and a deterioration in the flavor of his delicious fruit, which, like the apple, eems to obtain its greatest perfection of flavor in the highest latitudes where its cultivation is practicable.

Mysteries of the Ruby.

PROBABLY no gem ranks higher in popular estimation than the ruby when found in highest perfection, which is not so frequently the case as might be supposed. A variety of gems are sold as rubies which are not such, though in some measure resembling the true ruby. The latter is not only extremely beautiful as a gem, but it is of great scientific interest, presenting yet unsolved problems as regards its physical structure and its color.

Prof. Judd, in a recent lecture before the Royal Institution, London, discussed the mysteries that yet cluster around this gem, the most perfect specimens of which are found in Burmah. An abstract of the lecture is printed in the *Australian Mining Standard* (Nov. 3).

"The chief scientific interest of the ruby corundum flows from the extraordinary peculiarities of structure that it presents, as well as from the mysterious qualities that determine its striking color. It is found in crystals of a great variety of shapes, but all having a tendency to the peculiar habit of growth known to crystallographers as 'twinning.' By testing crystals of corundum with polarized light, its structure is found to be wonderfully complex, and under the microscope its exterior face is covered with a strange network of sculpture, indicative of molecular changes."

But there are other points of scientific interest. The true ruby is "pure, limpid, fiery red corundum,"—chemically, crystallized aluminum oxid. This substance also forms other highly prized gems, as the sapphire, emerald, aqua marine, etc. The true ruby is second in hardness only to the diamond. In its mass it nearly always incloses some foreign substance. A curious fact is "that these included bodies lie generally disposed in planes meeting each other at an angle of sixty degrees, the result being to produce the phenomenon of asterism, which is the term given to the white star of light which is observable on certain jewels cut with a rounded surface. Very frequently the imprisoned body is a minute bubble of gas or drop of liquid, containing sometimes little crystals of its own. The microscopic cavities containing these things are often very numerous. For a long time the nature of the gas and fluid contained in the cavities remained a mystery. The English philosopher, Brewster, was induced to investigate the subject by hearing that a ruby which an Edinburgh jeweller had placed in his mouth had exploded while in that position with unpleasant results. Other investigations followed; and it has now been made certain that the fluid is no other than liquid carbonic acid gas, reduced to that condition by great pressure."

The color of this mineral is due to its action on light, which, in the true ruby, has all its rays absorbed, except the red, which passes freely through the crystal. That the variety of color is due to differences in molecular structure is shown by the fact that the different examples of the same chemical substance absorb and transmit different rays. How this proves difference in molecular structure is shown in all comprehensive treatises on physics. "The color is distributed most irregularly, and some corundum crystals show in patches the tints of the ruby, the sapphire, and the emerald all mixed up together. These colors are, of course, due to the special way in which the structure of the crystal deals with the light passing through it, the ruby absorbing all the rays except those which emerge to give it its characteristic color. How greatly these colors depend on molecular and chemical changes going on in the crystal is obvious from the strange way some gems behave under light and heat. Prof. Maskelyne mentions a diamond which, when taken out of the warm pocket and allowed to cool on the table, turned a beautiful red. Prof. Judd startled his audience by declaring that the green glass panes used in the conservatories at Kew gradually changed through various shades of yellow to a distinct purplish hue under the prolonged action of light. Rubies change their color in a curious way under the action of heat. Bluish rubies turn perfectly green, and on cooling regain their original tint. The blue sapphire turns white, and the yellow corundum crystal becomes green. Then there is the strange property of 'Pleo-chroism' in the ruby family and its kindred; they exhibit different tints according to the side of the crystal you are examining. Some amorphous powdered oxid of aluminum was placed in a vacuum tube and subjected to the electrical discharge from a high-tension coil. It was shown that the white powder glowed with the brilliant red of the ruby, and that the glow continued after the discharge ceased,—a fact which seems a curious confirmation of the ancient idea that rubies would glow for a time in the dark. The same experiment was repeated with a variety of corundum stones, artificial rubies, etc., to show the greater or less degree of ruby glow exhibited by each."

The ruby has been imitated artificially, and the artificial product is scarcely inferior in color and general appearance to the natural gem, at least to the majority of stones sold as rubies; but art has not been able to imitate the other physical peculiarities described, nor has science yet been able to discover the natural methods by which they are created.

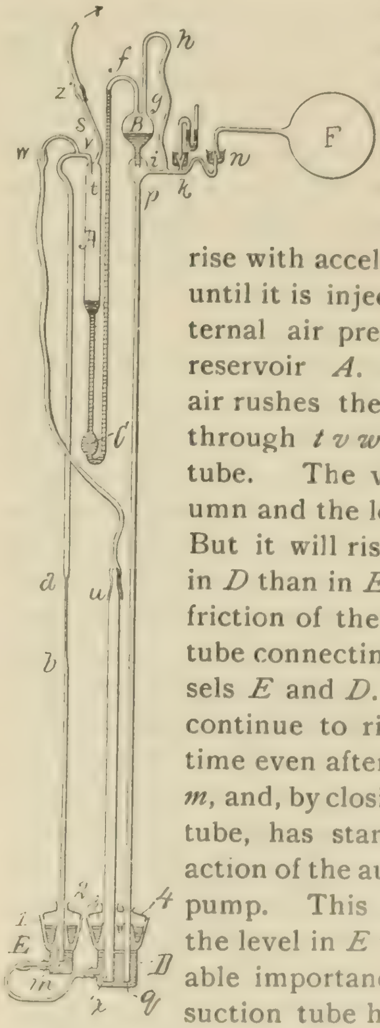
Automatic Mercury Vacuum Pump.

M. I. Pupin, Ph. D., Columbia College, in the January number of *The American Journal of Science*, describes a new form of mercury vacuum pump devised by him, which, it appears, ought to be more rapid in its operation and decidedly more convenient than vacuum pumps hitherto used for laboratory purposes. It employs no cocks whatever, and thus avoids one of the most annoying appurtenances of any apparatus wherein a vacuum is to be maintained. All who are familiar with the use of the "Sprengel" pump will probably concede the superiority of this apparatus, in which a suction pump is combined with a Sprengel pump. The degree of vacuum obtainable is the same as that produced with the Sprengel pump.

That part of the device which acts as a suction pump consists of a reservoir *A*, to which is joined the "suction-tube," *t v m*. A short branch tube, *v w*, is connected by a rubber tube, *w u*, to the wide tube, called the "valve-tube." The suction tube dips into a mercury vessel, *E*, and the valve-tube into a similar vessel, *D*. These vessels contain glass dishes 1, 2, 3, 4, "holding sulphuric acid for drying purposes," and are connected with each other by a rubber tube. The part *a b* of the suction tube has a cross-section, half the size of that of the rest of the tube.

B is the reservoir of the Sprengel pump, and *p q* the "tube of descent." A convenient length for this tube is one hundred and sixty centimeters. A lateral extension, *g h i*, equalizes the gas pressure above and below the mercury in the reservoir. The ground joints *k* and *n* are made air-tight by mercury contained in hoods, as shown. A siphon-barometer connection between *A* and *B* consists of a bulb *c* and a tube *c f*. The entire apparatus is of glass, except the rubber tubes.

"First a little mercury is poured through *z s* into *A* until the reservoir *c* is about half full, which is considerably more than sufficient to fill the tube *c f*. By means of a rubber tube, *z s* is connected then to a water-pump or any suction pump that may be available. Suppose that this auxiliary suction pump is capable of reducing the pressure in *A* to say forty millimeters, and suppose also that the barometric pressure is seven hundred and sixty millimeters. Owing to the action of the auxiliary suction pump, the gas pressure in *A* is continually reduced, and therefore also in *F* and in all other parts connected with *A*. Mercury rises in the valve and suction tubes, and also in the tube of descent. The extremity *m* of the suction tube is placed at such a distance below the initial level of the mercury in *E* and *D* that, when the mercury column in the suction tube is about sixty centimeters long, the mercury level in *E* (which sinks rapidly on account of the rising of the mercury into the valve tube) has just reached *m*. From that moment on, no more mercury gets into the suction tube. But, owing to the action of the auxiliary pump, the pressure in *A* is being still reduced; hence the column in the valve tube rises still higher, and the level in *E* sinks lower. In the meantime the column in the suction tube rises bodily, owing to the external air pressure, until it reaches the narrow part *a b*, when it begins to lengthen out; and, since *a b* is twenty centimeters long and the initial of the mercury column is sixty centimeters, it follows that this column will be lengthened out to seventy centimeters and no more. Hence, as soon as the pressure in *A* has been reduced by seventy centimeters, this column will rise with accelerated velocity until it is injected by the external air pressure into the reservoir *A*. The external air rushes then into *A* and through *t v w* into the valve tube. The valve-tube column and the level in *E* rise. But it will rise more rapidly in *D* than in *E* owing to the friction of the narrow rubber tube connecting the two vessels *E* and *D*. Hence it will continue to rise for a short time even after it has reached *m*, and, by closing the suction tube, has started again the action of the auxiliary suction pump. This retardation of the level in *E* is of considerable importance; for, if the suction tube had no contraction *a b*, and if the two levels in *E* and *D* were continually of the same height, then the mercury would be sucked up through the suction tube, not in form of solid columns, but in form of numerous drops separated from each other by air-bubbles. This would render the rapidity of action less satisfactory; besides, it would also cause a rapid oxidation of the mercury.



"As soon as the quantity of mercury injected into *A* brings the distance between the level in *A* and the point *f* into the vicinity of the barometric height, then the mercury begins to overflow from the siphon tube into the reservoir *B*, and the exhausting of *F* begins. By squeezing the tube connecting E and D, the rapidity of supply to B is varied; hence the quantity of mercury in B can thus very easily be kept within certain desirable limits."

Instruction of the U. S. Army Signal Corps.

SINCE the weather signal service was transferred to the Department of Agriculture, about two years ago, the army signal corps has been trained in its duties at Fort Riley, Kansas. The course of instruction, as we are told by George Heli Guy in *The Electrical Engineer* (Dec. 12), occupies six months, "and consists of both theoretical and practical instruction in electricity, topography, photography, signaling instruction to operators, and practice with the field telegraph and balloon trains. The practical course of electricity covers the ordinary laboratory measurements of E. M. F., current and resistance, and location of faults in telegraph wires; the construction, use, and repair of ordinary telegraph and telephone instruments; and the construction and maintenance of telegraph and telephone lines. The course in topography and photography includes rapid sketching and reconnaissance work, and the ordinary photographic operations—printing and enlarging; the application of photography to map-making is extensively used, and the camera is employed effectively in the captive balloon. The various systems of signaling and cipher are explained, and practice extends over various ranges up to 12 miles, with the flag, heliograph, torch, and flash lantern; and with the field telegraph kit, using both insulated cable and the bare wire system. The course of instruction to operators consists largely in practice with the Morse system until each of the sergeants can send and receive 35 words a minute on the typewriter, together with the regulations for transmission of messages and keeping the accounts of the various military lines, on which a considerable work is done.

"The means of communication by day used by the corps are flags, heliograph, and the field telegraph and telephone trains; and by night the torch, flash-lanterns, rockets, bombs, and searchlight. The method of visual signaling by flags consists in waving a flag to the right for a dot, to the left for a dash, and to the front for the space in the American Morse code. The heliograph, in brief, consists of a combination of mirrors by which a beam of sunlight is thrown in the required direction, and the dots and dashes of the Morse code are made by the opening and closing of a shutter placed in the track of the beam of sunlight. The heliograph has been used recently by the Corps up to a distance of 182 miles. At night the Morse code is sent either by the waving of a torch or flashes of light from the flash-lantern, a new type of which has been recently designed, of light weight, small size, and high penetrating power, the illuminant being coal oil, which is always available. It is the intention of the chief of the Corps to have a searchlight train—the plans for which have already been prepared—as soon as congress, in its inscrutable wisdom, shall begin to realize the necessity of preparing for war in time of peace."

An illustrated account of various appliances follows. The subjects of the illustrations are the heliograph; field telegraph train; outpost cable cart and telephone kit; signal balloon; erection of a field telegraph line; and the balloon wagon employed in balloon signaling and reconnoitering. The extent to which both electricity and aeronautics now aid in military operations is indicated by this paper, which in popular style clearly describes in detail the duties and operations of the signal corps, as systematically taught at Fort Riley.

The Fuel of the World.

THE animal, vegetable, and mineral kingdoms each furnish a greater or less share of the world's fuel. But the mineral sources of supply are now, and have been during the greater part of the present century, of far greater importance. A writer in the *Globe-Democrat*, quoted in *Progressive Age*, has gathered some interesting facts relating to the subject. Numerous patents for so-called artificial fuels have been procured. Corncobs saturated with petroleum, grasses and weeds compressed into blocks, and other organic materials and mixtures of organic with mineral substances figure in these patents. A large number of patents have been granted for utilization of coal dust, and a variety of materials for admixture with pulverized coal, and for holding it compacted into lumps or briquettes, have been employed. Among these materials are clay, molasses, sawdust, Irish moss, asbestos, lime, resin, cut straw, chaff, petroleum waste, peat, clam shells, charcoal from garbage, corn meal, wheat flour, sugar, seaweed, broken glass, lard, tar, forest leaves, and waste cork cuttings. This does not exhaust the list by any means.

The waste of many industries is utilized as fuel, either by itself or mixed with other kind of fuel. In most wood-working establishments the waste cuttings are so used, and in the shoe-manufacturing towns leather cuttings are said to form a large proportion of the fuel used by the poorer classes for domestic purposes. In many localities in the West maize has been largely used as fuel, and it makes a rousing fire. On the great Western plains "buffalo chips," the dried dung of the buffaloes, have cooked many a dinner for weary travelers. In Egypt, mummies; in British Columbia and among the Eskimau, oil, blubber, and inedible muscular fiber,—make fires for the people. Even the bodies of certain birds unsuitable for food, but rich in fat, are said to supply this need on the coast of Scotland.

Chemical products furnish ideal, though comparatively expensive, fuel. Alcohol is one of these much used in the arts, giving a pure, hot, smokeless flame, which renders its use almost indispensable in some delicate operations. The principal products of all practically available fuels, of whatever nature, are water and carbonic acid. If the fuel contains more hydrogen than carbon, water is the larger product. The burning of pure hydrogen in oxygen produces water only. The water passes off as steam, and is absorbed by the surrounding air. If, on the other hand, the fuel consists wholly or largely of carbon, carbonic acid gas is produced; and, unless the supply of oxygen is sufficient, many fuels give off a large amount of unconsumed carbon, either as carbonic oxid, or in the form of black smoke.

Lardarelo Boric Acid Works.

THESE works are situated in northern Italy, near the town of Monte Carboli, and were established in 1818. Mr. Wm. P. Mason has recently described them in a paper read before the Baltimore section of the American Chemical Society, giving an account of the natural sources of the boric acid and of the methods of obtaining and refining it. The district abounds in numerous fumaroles, the steam issuing from which contains boric acid to the amount of one-tenth of one per cent. These fumaroles have been tubed, mostly with 8-inch pipe. Besides the natural orifices, artificial fumaroles have been bored down to the steam zone, like artesian wells. The steam is discharged into cisterns of spring water, from which the boric acid solution is piped into settling basins to remove muddy sediment. Thence the solution passes into large leaden evaporating pans and is concentrated. It is next removed into crystalizing tanks, from which the crystals of boric acid are removed by wooden scoops, drained in baskets, and spread upon a steam-heated drying floor. The mother liquor is reconcentrated. About 200 hands are employed, and the annual product—about 1700 tons—is shipped to England.

The New Gas.

THE supposed new chemical element whose discovery was announced by Lord Rayleigh at the Royal Institution in August, 1894, is likely to prove a subject of much debate. Prof. Dewar, whose opinion will certainly have much weight in the scientific world, especially upon a point such as the existence or non-existence of any previously undetected body in the earth's atmosphere, has expressed doubt that the supposed new gas is anything except an allotropic form of nitrogen. Prof. Dewar's reasons for this surmise, and the difficulties which accompany the supposition that it is a chemical element existing to the extent of one per cent. in ordinary atmospheric air, were given in the *New Science Review* (Oct.) under the title "The New Element of the Atmosphere."

The avidity with which the public receives any statement of an alleged new discovery at the present time has led many other publications to announce this hitherto unknown substance—whatever it may prove to be—as undoubtedly a new element, and it may prove to be really such. But when men of Prof. Dewar's caliber still doubt, it is better to defer positive expressions of opinion, and wait for confirmative evidence.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated W=Words.

25800. The Lardarelo Boric Acid Works (Sc A S-Oct. 13.) 700 w.

†26921. "The New Element of the Atmosphere."—Considered by Professor Dewar (N S R-Oct.) 1000 w.

*27467. Lamp Accidents. Editorial (Iry-Oct.) 400 w.

*27486. Peking (Eng L-Nov. 30.) 2200 w.

*27519. Engineers of To-day—and Yesterday. James Reid—Thomas Williamson. Ill. (E Rev-Nov. 20.) 900 w.

*27526. Experiments in Aeronautics. Ill. Hiram S. Maxim, with Discussion (J S A-Nov. 30.) 6300 w.

27529. European Bottle Glass. Robert Linton (A M & I W-Dec. 7.) 900 w.

†27543. Sketch of Dr. John Locke. Ill. N. H. Winchell (A G-Dec.) 4800 w.

†27544. The "Slate Binders" of the "Pittsburg" Coal Bed. W. S. Gresley (A G-Dec.) 3300 w.

†27545. Springs: The Influence of Stratigraphy on Their Emergence, as Illustrated in the Ozark Uplift. Ill. T. C. Hopkins (A G-Dec.) 1000 w.

†27546. The Age of the Crystalline Limestones of Warren County, New Jersey. Lewis G. Westgate (A G-Dec.) 3400 w.

†27547. Geological History of the Missouri Paleozoic. G. C. Broadhead (A G-Dec.) 2800 w.

*27556. The Germans and Classical Archæology (A L-Nov. 30.) 2300 w.

*27571. Testing Wines (C T J-Dec. 1.) 2000 w.

27629. The Signal Corps of the United States Army: Instruction Work at Fort Riley, Kansas. Ill. George Heli Guy (E E N Y-Dec. 12.) 3500 w.

†27640. The Carrying Trade of the World. Michael G. Mulhall (C R-Dec.) 1800 w.

†27641. Mountain-Falls. W. M. Conway (C R-Dec.) 3000 w.

†27642. Contributions to Our Knowledge of the Genus Cyclus from the Carboniferous Formation of Various British Localities. Ill. Henry Woodward (G M-Dec.) 3000 w.

†27643. Physiographical Studies in Lakeland. J. E. Marr (G M-Dec.) 2500 w.

†27644. Notes on the Geology of Western Australia. Harry P. Woodward (G M-Dec.) 2700 w.

†27645. On the Application of the Sand-Blast for the Development of Trilobites. Ill. H. M. Bernard (G M-Dec.) 1500 w.

†27666. A Threatened City—Pekin. M. Rees Davies (F R-Dec.) 4000 w.

*27691. What Is Gravity? Ill. R. C. Shettle (E E L-Dec. 7.) 4000 w.

27712. Calcium Carbide and Acetylene. Francis Wyatt (E M J-Dec. 15.) 2300 w.

27729. The Fuel of the World (P A-Dec. 15.) 2000 w.

†27734. Discussion in New York of Prof. George D. Shepardson's Paper—"Suggestions for an Index of Engineering Literature" (T A I E E-Dec.) 11500 w.

*27736. Fire Protection. Edwin O. Sachs, with Discussion (J S A-Dec. 7.) 13000 w.

*27771. Technical Education. Address of Mr. Waterhouse (I C B-Dec. 7.) 2600 w.

*27775. Mysteries of the Ruby (A M S-Nov. 3.) 1100 w.

*27776. The Origin of Kerosene Shale. John W. Rock (A M S-Nov. 10.) 1500 w.

*27789. On the Composition of the Ohio and Canadian Sulphur Petroleums. Charles F. Mabery, with Discussion (J A E S-Nov.) 4500 w.

†27791. Engineering Fallacies. Address of Henry Morton (S In-Oct.) 8800 w.

27817. Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air. James Dewar (Sc A S-Dec. 22.) 1200 w.

27825. The Force Exerted by Tornadoes (E N-Dec. 20.) 900 w.

27828. Recent Tests of Smokeless Powders (E N-Dec. 20.) 2000 w.

27833. Big Trees "of California" Found Fossilized in Colorado. A. Lakes (M S P-Dec. 15.) 1700 w.

*27925. A New Platinum Standard of Light (J G L-Dec. 11.) 2000 w.

*27946. Changes in the Customs Tariff of Guatemala (B T J-Dec.) 2000 w.

*27947. Customs Tariff of British Guiana (B T J-Dec.) 1500 w.

*27948. Tariff Changes and Customs Regulations. Sweden, Russia, Denmark, Switzerland, France, Spain, Italy, Roumania, Chili, Japan, United States, Guatemala, Brazil, British India, Jamaica and Cape Colony (B T J-Dec.) 5000 w.

*27950. The World's Debt to Chemistry. H. B. Cornwall (Ch-Jan.) 6000 w.

*27998. The Manufacture of Salt. Thomas Ward (J S A-Dec. 14.) 9500 w.

*28000. Professor Victor Meyer's New Method of Determining High Melting Points. A. E. Tutton (N-Dec. 13.) 900 w.

*28029. A Systematized Photometrical Nomenclature (J G L-Dec. 18.) 3300 w.

†28037. A New Flying Machine. Ill. Hiram S. Maxim (C M-Jan.) 5200 w.

*28069. Engineers of To-day—and Yesterday. William Arrol. Ill. (E Rev-Dec.) 1000 w.

*28073. The Engineering Industries of Glasgow.—Descriptions of Leading Works. Ill. (E Rev-Dec.) 10800 w.

†28089. Late Glacial or Champlain Subsidence and Reëlevation of the St. Lawrence River Basin. Warren Upham (A J S-Jan.) 7500 w.

†28090. On Graphical Thermodynamics. René de Saussure (A J S-Jan.) 7500 w.

*28092. Mr. Bryce's New Chapters on Current American Questions. Albert Shaw (R of R-Jan.) 4500 w.

*28118. The Broader View. G. W. Dickie (I S F-Jan.) 4400 w.

*28132. Forestry. J. Michael, with Discussion (J S A-Dec. 21) 14000 w.

*28146. Glass Historically Considered. Anon. (I C B-Dec. 21.) 2200 w.

*28149. Gilding Glass. Anon. (I C B-Dec. 21.) 1000 w.

28176. Practical Measurement of the Velocity of the Wind (Sc A S-Jan. 5) 1000 w.

†28184. An Automatic Mercury Vacuum Pump. Ill. M. I. Pupin (A J S-Jan.) 800 w.

†28187. On Electrosynthesis by the Direct Union of Weak Organic Acids. J. B. Weems (A C J-Dec.) 6500 w.

†28188. Pentosans in Plants. G. de Chalmot (A C J-Dec.) 6300 w.

†28189. On Chemical Equilibria as Temperature Functions. J. E. Trevor and F. L. Kortright (A C J-Dec.) 2500 w.

†28190. A New Formula for Specific and Molecular Refraction. W. F. Edwards (A C J-Dec.) 1700 w.

†28194. Carborundum; Its History, Physical Properties and Chemistry. John Alexander Mathews (S M Q-Nov.) 1800 w.

*28212. On the Problem of Aerial Navigation. William Bosse (A E R J-Jan.) 1300 w.

*28213. Hydrogen Gas Apparatus for the United States Signal Service. Ill. (A E R J-Jan.) 1200 w.

*28214. Voyage of the Balloon "Svea" at Stockholm, Sweden, Oct. 19, 1893. H. G. Hazen (A E R J-Jan.) 900 w.

*28215. "Soaring" Experiments. Ill. A. M. Herring (A E R J-Jan.) 1000 w.

†28234. A Review of Stereo-Chemistry. Stewart Woodford Young (J F I-Jan.) 3200 w.

28261. Thermal Storage. Ill. Nelson W. Perry (W E-Jan. 5.) 5500 w.

*28331. On the Relative Frequency of Different Velocities of Wind. William Ellis (C G-Dec. 28.) 900 w.

*28346. On a Remarkable Earthquake Disturbance Observed at Strasburg, Nicolaiew, and Birmingham on June 3, 1893. E. Von Rebeur-Paschwitz (N-Dec. 27.) 3000 w.

*28353. Explosives and Their Modern Development. Vivian B. Lewes (J S A-Dec. 28.) 7000 w.

†28364. An Investigation of the Twitchell Method for the Determination of Rosin in Soap. Thomas Evans and I. E. Beach (A C J-Jan.) 2400 w.

†28365. Vulcanization of Small Hard Rubber Specialties. John T. Usher (I R W-Jan.) 1200 w.

†28366. American Rubber Erasers by the Ton. Gustav Heinsohm (I R W-Jan.) 1000 w.

†28367. The Insurance of Rubber Factories (I R W-Jan.) 900 w.

†28368. Official Statistics of India-Rubber and Gutta-Percha (I R W-Jan.) Table.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I-Began May—9 parts to date—45 cts. each).

22848. Physical Units. Magnus McLean (E E L-Began June 8—10 parts to date—30 cts. each).

24462. Graphic Statics. W. W. F. Pullen (P Eng-Began Aug. 10—10 parts to date—30 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng-Began Oct. 13—6 parts to date—15 cts. each).

26996. Statically Indeterminate Structures and the Principle of Least Work (E-Began Nov. 9—3 parts to date—30 cts. each).

27198. Refrigeration and Ice-Making (S E-Began Nov.—2 parts to date—15 cts. each).

27548. Constructive Engineering on the Pacific Coast. Ill. (I S F-Began Dec.—2 parts to date—30 cts. each).

27586. Cathode Rays. E. E. Brooks (E R L-Began Nov. 30—Ended Dec. 14.—2 parts—30 cts. each).

27922. The Nature and Use of Industrial Explosives. J. Daniel (C G-Began Dec. 14—2 parts to date—30 cts. each).

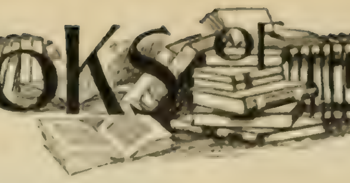
27959. Ferdinand de Lesseps (E-Began Dec. 14—Ended Dec. 28—3 parts—30 cts. each).

28001. Endowment for Scientific Research and Publication. Addison Brown (N-Began Dec. 13—Ended Dec. 20—2 parts—30 cts. each).

28231. The Animal as a Prime Mover. R. H. Thurston (J F I-Began Jan.—1 part to date—45 cts).

28263. The Handling of Men. Foster Crowell (E R-Began Jan. 5—1 part to date—15 cts).

NEW BOOKS OF THE MONTH



Architect, Owner and Builder Before the Law. A Summary of American and English Decisions on the principal questions relating to building, and the employment of architects, with about 800 references, including also, practical suggestions in regard to the drawing of building contracts and forms of contracts suited to various circumstances. By T. M. Clark, Fellow of the American Institute of Architects. New York: Macmillan & Co., 1894. [8vo., 387 pp. Price, $3.]

The purpose of this book is to relieve as much as possible the difficulties experienced by parties to controversies relating to building, resulting from ignorance of the legal principles underlying the various questions likely to arise in the execution of building contracts. The relation of the architect to the owner, the architect's duties to his employer, the position of the architect in cases when the cost exceeds the limit, the responsibility of the architect for his own work, the architect's authority as an expert, the authority of the architect acting as agent for the owner, architects' claims to compensation, architects' commissions, complications arising from sickness or death of the architect, the ownership of plans, the relation of the architect to the builder, the authority of the architect over the builder, architects' certificates, and the whole subject of contracts relating to building are treated, and the principles laid down are sustained by the citation of a large number of cases recorded in law reports.

Theory and Practice of Design. An Advanced Text Book on Decorative art, being a sequel to the author's, "Lessons on Decorative Design." By Frank C. Jackson, Lecturer on Principles of Ornament, Advanced Design, and teacher of Technical Art Processes, etc., in the Birmingham Municipal School of Art. 700 illustrations. London: Chapman & Hall, Ltd. Philadelphia: J. B. Lippincott & Co., 1894. [8vo., 216 pp. Price, $2.50.]

A more advanced treatise than "Lessons on Decorative Design," previously written by the same author, this book ought to share the great popularity which the earlier work received. It is not a mere collection of designs, but an analytical, thorough-going exposition of the principles of design. Its tendency is, therefore, not toward a school of bald imitation, but toward originality in conception and execution. The great number of well executed illustrations amply exemplify the principles laid down.

Pray's Steam Tables and Engine Constants. For facilitating all calculation upon indicator diagrams of various problems connected with the operation of steam engines, from reliable data, and with precision. Compiled from Regnault, Rankine and Dixon, directly, making use of the exact records. By Thomas Pray, Jr., C. C. and M. E., Member of many Societies, &c. New York: D. Van Nostrand & Co. London: E. & F. N. Spon, 1894. [8vo., iv-85 pp. Price, $2.]

These tables, prepared by an engineer of extensive experience, are the result of a well-directed effort to bring together in a single volume, all necessary data for computations in testing steam engines, and, so far as relates to motive power of steam, all data required in designing steam engines to develop from a definite rate of fuel consumption, a definite amount of power. Accuracy and convenience have been the leading aims of the work. To this end every table has been computed, and nothing has been copied. Rankine and Regnault are accepted as the highest authorities. Each table is supplied with explanatory text, and there has thus been embodied in compact and convenient form the data most used in boiler tests, computations of duty performance of pumping engines, and analysis of indicator diagrams.

Transactions of the Association of Engineers of Cornell University. Volume II, 1893-1894. Containing addresses by non-resident lecturers, miscellaneous papers, constitution and by-laws of the Association. Ithaca, New York. [Pamphlet, 8vo., 140 pp. Price $1.]

Besides the president's annual address, this volume contains a lecture delivered by Clemens Herschell of New York, before the engineering students of Cornell University, February 2nd, 1894, on "Frontinus and his II Books on the Water Supply of the City of Rome A. D. 97." Also notes of certain field methods used on the Survey of the Mexican boundary in 1892 and 1893. By John F. Hayford, C. E., Assistant Astronomer International Boundary Survey U. S. and Mexico, and some notes on fire protection engineering, by John R. Freeman, Civil Engineer, Boston, Mass. The latter paper is profusely illustrated with examples of so-called fire-proof standard slow burning mill construction, examples of combustible architecture, roof construction, construction of floors, and details relating to building with the express view of resisting combustion.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM. By Sylvanus P. Thompson, D.S.C., B.A., F.R.S., F.R.A.S., Principal of and Professor of Physics in the city, and the Guilds, of London, Technical College, Finsbury; late Professor of Experimental Physics in University College, Bristol. New Edition. Revised throughout with additions. New York: Macmillan & Co., 1895. [12 mo., 628 pp. Price $1.40.]

THE name of the author of this book would be in advance a full guarantee of its worth to those familiar with his works, and having knowledge not only of his attainments as a scientist, but also of his ability as an instructor. They would expect, and would find the book to be fully up to date as to its facts, to be as comprehensive as is possible in such an elementary treatise, and to present the whole subject in most perspicuous style. Although originally published in 1881, the book has been largely re-written to bring it fully abreast with the great advancement of electrical science during the intervening thirteen years. The style of printing and the illustrations are excellent. A full table of contents is supplemented by a copious index, and a collection of problems and exercises rounds out and complete the treatise.

MODEL ENGINE CONSTRUCTION. WITH PRACTICAL Instructions to Artificers and Amateurs. By J. Alexander. Containing numerous illustrations and twenty-one working drawings from original drawings by the author, and re-drawn by C. E. Jones, New York: Whitaker & Co., 1894. [12mo, 324 pp., price $3.00.]

THIS book is more especially designed as an aid to amateur constructors of model steam engines, with their boilers and fittings, including stationary, locomotive, and marine engines, model railways, and railway cars. Also some instructions are given in the art of pattern-making, and the book concludes with directions for constructing a hot-air engine. As the construction of models of machinery is good mechanical training, the book will be useful for students and apprentices in mechanical engineering.

RENAISSANCE AND MODERN ART. BY WILLIAM H. Goodyear, M. A., Lecturer on History of Art in the Cooper Institute, Brooklyn Institute and Teachers' College. Author of "Ancient and Modern History," "A History of Art," "The Grammar of the Lotus," "The Roman and Medieval Art," etc., etc. Flood & Vincent. The Chautauqua Century Press, Meadville, Pa., 1894. [12mo, 310 pp., bound in buckram, coated paper, gilt top, edition *de luxe*. Price $2.00.]

THIS is a book that ought to be in the library of every student of art, to whatever branch he may be devoted, whether architecture, sculpture, or painting. One of its best features is its numerous references to the best works for art students to peruse, making it an admirable guide to art literature. It contains two hundred and ten engravings, executed from photographs taken by permission of artists and owners from works in their collections.

ELECTRIC RAILWAY MOTORS. THEIR CONSTRUCTION, Operation, and Maintenance, and Elementary Practical Handbook for those engaged in the Management and Operation of Electric Railway Apparatus, with Rules and Instructions for Motormen. By Nelson W. Perry, E. M. New York: Street Railway Gazette Co. 1894. [12 mo., 288 pp., Price, $1.00.]

THIS is a re-publication in book form of a serial first printed in the *Railway Gazette*. The purpose of the book, which seems well carried out, is to place before motormen and switchmen an exposition of the principles involved in the use of the motors employed by them in their occupation, of which they often have very meagre and imperfect notions. The treatise has been prepared with direct reference to its adaptation to this class of men, and is, therefore, free from technicalities, except such as cannot be avoided in any treatise upon this subject.

PROCEEDINGS OF THE INTERNATIONAL ELECTRICAL CONgress, held in the City of Chicago August 21-25, 1893. Published by the American Institute of Electrical Engineers, 26 Cortlandt street, New York, U. S. A., 1894. [Oct., 488 pp., Price, $3,00.]

THE International Electrical Congress at the Columbian Exposition was one of the most important international congresses held in connection with the great

Fair, in respect both to the scientific standing of those who took part in it, and to the character of its proceedings. Very rarely in the history of the world has such a galaxy of intellect been gathered for the advancement of a single scientific cult. As was anticipated, the proceedings make a book of far more than usual interest and importance. The portraits of the official delegates, grouped in an admirable frontispiece, and the standard abbreviations adopted by the congress and printed at the end of the volume, are alone worth the price of the book.

Pictures of the Future. An Experiment in a Model Social World and What Came of It. By Eugene Richter, Member of the Imperial German Parliament. Translated from the German by Amos Nurgesser Titus. New York: Optimus Printing Co., 1894. [12 mo., 190 pp., paper. Price 50 cents.]

One of the Paragon Library Series. The author, having set his imagination free to form a vision of the state of society that would result from the triumph of socialistic principles, assumes that he himself is a socialist, and pictures the disappointments, heart-burnings, and sorrows experienced by himself and his family in their unsuccessful attempts to adapt themselves to their new environment. They are represented as finding everything very remote from the felicity which the new regime was expected to bring to every member of the community. A comical as well as satirical picture is painted of the public cook-shops-children's homes, refuges for people of advanced years, the new currency, and the other institutions that accompanied the new social status. In short, the book is a sharp-edged satire upon the fallacies of the Socialistic scheme.

BOOKS RECEIVED.

Office of Naval Intelligence, General Information Series, No. XIII.=Information from abroad. Notes on Year's Naval Progress. July, 1894. Navy Department, Washington. [458 pp., paper covers.]

The State Agricultural College, Fort Collins, Colorado.=Agricultural Experiment Station Bulletin No. 27. 3d Edition, revised, of Bulletin No. 13. The Measurement and Division of Water. Approved by the Station Council, Alston Ellis, president.

Watts, W. L., M.E., Assistant in the Field.=The Gas and Petroleum Yielding Formations of the Central Valley of California. Sacramento State Office: A. J. Johnston, Superintendent State Printing, 1894. [Pamplet. 8vo., 100 pp.]

Storms, W. H., Assistant in the Field.=Methods of Mine Timbering. Sacramento: State Office: A. J. Johnston, Superintendent State Printing, 1894. [Pamphlet. 8vo., 54 pp.]

Washington: Government Printing Office.=Annual Report upon the Improvement of Harbors on Lake Ontario, east of Oak Orchard, New York, in charge of Dan. C. Kingman, Capt., corps of engineers, U. S. A.: Being Appendix P P of Annual Report of the Chief of Engineers for 1894. [Pamphlet. 8vo. 44 pp.]

Hight, G. A., Deputy Conservator of Forests, Bombay.=Report on Forest Administration in Germany. Calcutta: Office of the Superintendent of Government Printing, India, 1894. [Pamphlet. 8vo. 18 pp.]

Pew, Arthur.=Notes on Government Railroads. [Pamphlet. 68 pp. Price 35 cents.]

Fifth Annual Report of the Board of Public Works of Kansas City, Mo.=For the fiscal year ending April 16, 1894. Kansas City, Mo.: Lawton & Burnett, printers, 1894. [Pamphlet. 8vo. 103 pp.]

Fish, J. C. L., C. E., Assistant Professor of Civil Engineering in the Leland Stanford, Jr., University.=Lettering of Working Drawings. New York: D. Van Nostrand Co., 1894. [Quarto, 13 plates, presenting a great variety of styles copied from good samples of lettering on actual working drawings, &c., and 9 pages of text, all printed on heavy coated paper. Board, price, $4.00.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Babcock & Wilcox Co., 29 Cortlandt St., New York, U. S.A.=Steam, its Generation and Use. With Catalogue of the Manufactures of the Babcock & Wilcox Co., 8vo., 182 pp., 28th Edition. [The number of editions this book has passed through is sufficient evidence of its value and rank in the literature of steam-engineering. Its reliability as a guide to the best steam practice has never been disputed, and its popularity is constantly increasing. It will be understood that, while the catalogue of the firm that publishes it is a feature of the work, a large proportion of it is occupied by a thorough-going treatise upon the manufacture and construction of boilers, and their operation, and the applications of steam to power and heating purposes. The information given is entirely up to date.]

W. J. Johnston Co., Ltd., 253 Broadway, New York, U. S. A.=Catalogue, unpaged. [Enumerating and describing a large number of electro-technical works of character and standard value.]

For additional catalogues see Improved Machinery, page 38.

THE

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THE RELATION OF THE RAILWAY TO ITS EMPLOYEES.

By W. H. Canniff.

IN considering the relations of the railway to its employees every thinking person will at once recognize the vast complications which the problem presents. Not only is it necessary to provide for prompt handling of merchandise under every conceivable condition, but such provisions must be made as will insure the safety and comfort of thousands of passengers who use the roads, as well as those of the men employed.

Again, the railway company is known to the communities through which its lines pass only in the persons of its accredited agents, and upon their tact and general bearing must largely depend the esteem in which the company is held, resulting in coöperation or antagonistic relations as the case may be. Not only does this apply to commercial relations, but also to such police regulations as look to the clearing of streets and similar requirements on a long line of railway. How to insure this desired result is one of the most perplexing problems which confront a manager.

It is manifest that good and efficient discipline is a prime factor, of which, to my mind, absolute justice is the foundation-principle; and on this basis can the obligation of a railroad company to its employees and to the public be best carried out. It is obvious that, whatever the rules and regulations, their execution depends upon a large number of men surrounded and largely influenced by varying conditions. This being true, it follows that, in the formation of all rules governing the operation of a railway, great care should be exercised to see that they are based on correct principles, neglecting no

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feature which experience has shown to be necessary in an intelligent execution of such rules, and taking into account the various phases which affect human nature as a whole, remembering that those who are to execute the rules are a part and parcel of the human family.

At this point, however, the work has just begun. While to the mind of an intelligent officer the rules or instructions are clear and explicit, he should bear in mind that their execution depends largely upon an equally intelligent comprehending and understanding by those who are to carry them into effect.

When it is realized that an author usually devotes chapters to definition in order to convey exact ideas, it will be admitted that to give correct expression to ideas much thought and study are required, and that those who are to receive the idea must understand the language used for its conveyance. Hence the great necessity for intelligent direction is apparent.

Men who do not have a fairly intelligent idea of what may be termed the general fitness of things are very low down in the scale. Much more plainly than their employers imagine do they see the relation of the order, or instructions, to the work to be done. The nature of their work makes them keen observers in most instances, quick to recognize in the instructions even the slightest defects, or mistakes, or the want of application to the work in hand, which cannot fail to weaken their respect for those who issue them; and, while the mistake may be easily corrected, the effect upon the men remains.

They have the same hopes and fears, aspirations and desires, as other men, and are surely deserving of every consideration when the importance of their work is remembered. That the employee will do more efficient work if his interest and coöperation are secured cannot be controverted, for the evidence is at hand in every walk of life. When fairly balanced, the interests of the railway company are identical with those of the employee, for with good discipline and highly efficient labor the comfort and safety of the public is conserved, the investment is made profitable, and good wages can be maintained. How can this desideratum be achieved?

First: by most painstaking care in the preparation and promulgation of rules and instructions.

Second: by clearly conveying to the employee what is desired, it being his right to know what is expected of him under all circumstances.

Third: by having him understand that the rules are such that, if intelligently executed, they will insure his own well-being, as well as that of the company, and that compliance with them will result in recognition, either in the way of commendation or promotion.

Fourth: by strict attention to matters of discipline, never permitting employees to be suspended or dismissed except for good and sufficient cause,—this to be shown by clearest proof of violation of rules that were fully understood, and such violation to be invariably disciplined, without waiting for the evil consequences which such rules were intended to avoid.

Fifth: by a consistent course of action which will impress upon the employee the fact that it is the earnest purpose of the company to render him exact justice in every instance.

Men entrusted with the care and responsibility of handling a large body of employees widely scattered over an extended territory must have exceptional talent in order to secure the best results. They must fully understand how vast the interests are which are committed to their care, and upon their fidelity and wise direction the welfare of many employees and their families depends.

The first proposition—that great care should be exercised in the preparation of rules and instructions—is certainly of vast importance, owing to the fact that these are, of necessity, the foundation upon which the whole structure is to rest. They must be such as practice and experience have approved. For illustration, in the preparation and adoption of a schedule, affecting, as it does, during its existence, the movement of every train or engine, there is most valuable information to be gained by consulting those employees whose duties bring them in daily contact with the service performed. Thus not only does the management get the benefit of the employee's experience, but the employee is encouraged to study more closely the problems which arise in the service, with a full knowledge that his ideas will receive the consideration they deserve.

Again, much stress must be laid upon the second proposition. Not only must the foundation of the rules or instructions be clear and conclusive to their author, but the rules must be so worded as to convey to the employee the desired meaning; and to this end the employee should be encouraged to promptly make it known if there is anything in his instructions which he does not fully and clearly understand, thus giving him incentive to better comprehend, and confidence to ask for necessary explanation.

The third proposition calls for such wording of the rules as will adequately explain their purpose. Where for various reasons they cannot be so worded, a duty may devolve upon the management to explain the reasons for issuing them. It will be said that this is impracticable, but I do not deem it so. If a well-disciplined and highly efficient corps of men is desired, additional duties will be forced upon the management, as well as upon the men. To give the men a logical understanding of the rules is not as difficult as it may appear, and the advantage to be gained in the moral effect upon the minds of those who are to execute more than compensate, in my opinion, for the additional care and labor. It obliges the maker of the rule to exercise greater care in its preparation, in order to defend it when questions arise, and leaves the employee no possible excuse for failing to carry out its provisions.

In considering the fourth proposition, we come to what may properly be termed the most vital point of all.

To write an order, or issue instructions, is a simple matter. To secure the desired result is quite another matter ; and, even when care has been exercised, and the instructions are based on good and sufficient reasons, a proper execution is difficult to attain.

The science of good government has occupied the minds of able men for centuries, and various methods are proposed in governmental affairs. Legislation in many instances is followed by failure through neglect of the underlying principle that governs all human action,—*viz.*, that man must be held to strict accountability for his actions, in whatever he is required to do. An infraction of nature's law brings inevitably a punishment, mild or severe. It seems, therefore, fair and reasonable that the employee, after assuming his obligations, should be held to a strict accountability, and that a reprimand, suspension, or dismissal should follow an infraction of his instructions. Before inflicting the penalty, however, ample opportunity should be given him to present fully his side of the case, and action deferred until his fault or blamelessness has been clearly shown by good evidence.

After many years' experience, I have yet to see men fail to recognize and acquiesce in decisions arrived at by this method ; and still more positive confirmation of its value is found in the remark, made to me by a distinguished railroad manager, that, after thirty years' service in charge of large numbers of men, and during that time having reprimanded, suspended, and dismissed a great many, he could not recall a single instance where such men did not continue to be his friends. What stronger proof could be offered that his relations with the men were governed by justice and fair dealing ?

To impress the employee with the fact that justice will be done, as contemplated in proposition five, it is necessary to treat all infractions logically, and to attend closely to those small details which affect his relation to the company. This, for the busy manager, is difficult ; and it will be said that, with all this care and attention on the part of the manager, or superintendent, there will be many employees on whom it will have no effect. This is true ; but this very method of investigating acts and judging conduct becomes at once the active agent for ridding the service of such men, while a marked raising of character will be observed in those who are amenable to its influence, so that the efficiency of the service will be improved at both ends, and in a most striking manner, indicating how essential is constant vigilance on the part of the manager to the development of the efficiency which it is aimed to secure.

We must remember the great magnitude of the railway interests, and that nearly the whole of their wonderful development has taken place during the past fifty years. The railway corporation, even more than any other, is of necessity entirely removed from contact with the men, and the managing officer should aim to serve as a link connecting the interests of the men with those of the corporation. Personal contact, even by the manager, is necessarily infrequent and spasmodic, but all the advantages of personal contact can be secured by the just and impartial review of questions which arise between the men and subordinate officers. While the decisions thus rendered can serve as precedents for the determination of similar questions as they again arise, in this manner also the caprice of judgment shown in passing on similar offences on separate portions of the line can be corrected, and all divisions be brought to act in unison, this uniformity of action forming an essential part of that justice which is deemed essential to good discipline.

The public are daily becoming more exacting, and of necessity the railways must meet the changed conditions. The older employees must of necessity adapt themselves to the new order of things, which means, in many instances, a change in the habits and practices of years. This can best be accomplished by appealing to their reason, as indicated above, and gradually bringing them to act from proper motives, through conviction that good results will be attained thereby.

As one illustration of the effect of appealing to men's understanding, I will cite the following:

It became necessary to change the location of a division terminal, in consequence of which the runs of one end were made much shorter than those of the other. Soon after, the men making the shorter runs demanded the same remuneration that they had received for the mileage formerly made, although the men on the longer runs, under the new arrangement, did this work, and received the pay for it. It was claimed that the division time-cards had not been changed, and the men insisted that the time-card distance should rule. Answer was made that their request would be granted, and they must decide for themselves whether the time-card distance or the actual distance run should govern. The time-card distance was at first decided upon; but, when it was shown that, if the time-card distance governed in the one case, it must also govern in the other,—that, if the men of one division received pay for thirty miles which they did not run, the men on the other division, under the same rule, would run thirty miles without receiving any pay for the same,—the men reconsidered their request, their acquiescence to the existing arrangement being given in such a manner as to leave no doubt of their conviction of its justice.

To show the force of emulation, I may state that, while in charge of a track division comprising fifteen sections, each under a foreman, I have repeatedly instructed seven of the foremen to perform work at the ends of their sections tending to materially improve the condition and appearance. In no single instance did I fail to find the eight alternate foremen doing the same work not later than the second day, although no instructions whatever had been given them, the contrast and improved appearance of the adjoining section impelling them to similar action. In this manner the men are mentally and morally strengthened, while the quality ot their service is much improved.

The apprentice who enters the railway machine-shop with proper qualifications for success will in good time become a master workman, capable of directing the building of a modern locomotive. Such men, taken as a class, will be men of fixed ideas and purpose. Their work has been of that nature which requires exactness in every detail, performed under the watchful care and within reach of the helping hand of a resident official.

To place such a man in charge of the machine he has built, which, in its frequent trips by night and day, surrounds him constantly with uncertainties, calling for exercise of individual judgment and the faithful discharge of duty in the absence of all personal supervision, is to absolutely change his environment, and consequently his ideas and inclinations ; and, although the same person, yet he is in an entirely different class, requiring different treatment, all of which should and will be considered by the intelligent officer. In other words, the latter will recognize the plain distinction between employees whose duties tend to fixed results, and those whose duties are full of uncertainties, as in train service.

Absolute frankness upon the part of those in authority, when dealing with the men, forms an essential part of the relations which the railway company should bear to its employees. If requests are made which cannot consistently be granted, it should be answered that such is the case, it being far better that the employee should be disappointed at the time rather than suffered to entertain hopes not to be realized in the future.

In many instances promises of promotion are made with an undoubted intention to fulfil them ; and yet, as every officer knows, circumstances over which he has no control arise to prevent the fulfilment. Not only are such failures disappointing to the parties directly interested, but they involve a lowering of confidence in the minds of the employees in general, which must tend to weaken discipline, however slightly. As no explanation can change these feelings, avoidance of promises is the wiser course.

In the acceptance of new men for the various branches of the service, it is of advantage to the company, and positively due to the men already employed, that the existing standard of efficiency should be maintained. To this end suitable references should be required, with the understanding that the applicants will not be employed until such references have been looked into, and assurances received that the applicant is worthy in character and gives evidence of capacity, as only by such discriminative methods can justice be done to the employees whose capacity has been proved.

In the relations of the railway to the employee, it is the part of wisdom for the railway officer, when positions become vacant, to promote, whenever possible, some one of the employees already in service. It is true that in the strict sense the obligation of the company to the employee ceases when the stipulated sum has been paid him for the service rendered ; it is equally true that with the performance of a fair month's work the employee has discharged his full duty ; but, as we seek to increase the efficiency of the service, evidences of unusual loyalty and energetic performance of duty should be met with due recognition by promotion to such positions as call for the exercise of the qualities displayed.

What more powerful incentive can be placed before men than the feeling that in due time faithful service will be recognized, and promotion be reasonably certain ? An employee, in answer to my question as to how long he had been a freight-brakeman, replied :

"Seven years."

"Are you not getting discouraged ?"

"Oh, no," said he, "I know my time will come pretty soon, if I do my duty."

This kind of incentive is constantly felt, and must exert a more powerful influence than any other ; and the feeling is not confined to employees.

Since the improvement of the men is an advantage to the service, there is much to be gained by railway companies in taking an interest, and aiding pecuniarily, in the provision of suitable quarters at principal points where employees can spend their leisure hours surrounded by good influences. In this way the Young Men's Christian Associations have rendered valuable service, and it is a pleasure to note the rapidly-increasing interest shown in this direction by many railway officials, and the appreciation of such efforts by the employees, as evidenced by increasing attendance and interest, thus conclusively proving the good results upon men when they become impressed with the evidence of concern for their personal welfare.

Thus it is that we find large numbers of men engaged in an occupation the nature of which requires keen perception and close adherence to fixed rules. Any failure on their part may result in loss of property or danger to human life,—a most exacting service ; yet, considering the interests involved in the movement of freight and passenger trains, how faithfully their service is performed ! But success in this as in any other form of government can only come with close study and constant watchfulness.

The relations of the railway to the employee being impersonal, the manager must in his own person fill the void. The employee is, in a great measure, what the manager's conduct makes him. If the manager desires an interest in the work aroused, he must show an interest in the men. When strict and intelligent obedience to the rules is demanded, the manager must not shrink from a strict and intelligible construction of them. If he wants the employees to fearlessly discharge their duties, he must as firmly uphold them where no blame is shown.

When more than usual zeal is manifested, promotion is a wise means of proving appreciation. Wisdom in judgment will command respect, honesty of purpose will win confidence ; and, when these reciprocal obligations are recognized and performed, the relations of each to each will be better understood, a more friendly feeling will arise, fewer strikes will prevail, and, in the determination of the honest differences which may arise, the convictions of reason will prove a more potent factor than coercive force.

RELATIONS OF THE EMPLOYEE TO THE RAILROAD.

By Cy Warman.

AS the shifting sands in the bed of a river are constantly changing the channel, so are the conditions of the country constantly changing the relations of the railroad employee to the railroad.

When the country is prosperous and all the railroads are running full-handed, employees are apt to air their grievances and ask for a raise in wages as often as a dividend is declared. When times are hard and hundreds of idle men are abroad in the land and locomotives are rusting in the round-houses, railway managers are apt to ask the employees to submit to a reduction in wages as often as a fresh batch of men are discharged and sent adrift. These facts may not be very complimentary to either side, but they are facts, I fancy, all the same.

The railroad company proper is regarded by the average employee as a mythical soulless something, ever invisible and always out of reach. The struggle is really between the men and the management, the employees and the officials ; and, as they are all employees,—from the president to the tie-tamper ; from the master-mechanic to the poorly-paid wiper,—we must have a division to begin with. Out of this great body we must find the fighting forces for two armies, absurdly arrayed : one under the flag of "Capital," the other bearing the banner of "Labor."

This condition of things is all the more inconsistent when we remember that the real fighters are all laborers ; only, one side has succeeded, the other is struggling to succeed. And how are we to know them ? When does the "employee" become an official ? Ah ! that's the easiest thing in the world. For example, this change in the life of a locomotive-engineer comes the day he is promoted to be travelling engineer, or round-house foreman. It comes to the conductor when he is made superintendent of a division ; to the telegrapher when he becomes a dispatcher or train-master. The other employees come in awkwardly, congratulate the new official, and then go back to the boarding-house and lock their trunks. Here is a parting of ways. From this day the new official walks on the other side of the street, regarding the promotion (for which all are striving) almost a misfortune. At the end of a week his room-mate leaves him, and he goes also,—to live in a better place. At the end of a fortnight he finds that he has, almost unconsciously, changed his mode of living and his associates.

He sits no longer in the councils of employees, for he stands for the company,—for Capital. In many cases he pays up his dues and takes an honorary membership, or withdraws finally from the Brotherhood. He is so different in his new place that sometimes he is accused of being "stuck on himself." I put it that way, for it is precisely as the "other fellows" will put it; and I have dwelt upon this point to show that there is no mistaking an employee for the "company," which is simply the management. It would not be just to say that the new-made officer deserves all the bad things said of him, nor would it be right to say that the unpromoted employees are wholly to blame. They have simply all dropped down the wrong leg of the "Y," and nobody has taken the trouble to back them up and set them right. Then it is always so much easier to convince a workingman that he is getting the worst of it than to show him that he is prosperous and ought to be happy. That's why the professional agitator has such smooth sailing. Man is a scrappy animal at best, and I think that the constant strain under which the railroad employee works tends to make him especially irritable, as the constant watchfulness of his nature tends to make him suspicious of signals which are not perfectly plain to him.

The railroad manager at his office, dictating letters, directing business, and hearing grievances, is a different man altogether when seen at the club, at the races, in Sunday-school, or at home; but the less experienced employee is always the same on and off duty. He has not yet learned how to forget his work,—to put it aside, and rest his weary brain. He railroads, not only earnestly, but all the time: on the rail, in the round-house, the barber-shop, and the boarding-house. When he wants his plate changed, he tells the waiter to "switch out the empty and throw in a load."

The little jealousies and animosities just described exist among the employees as well as between the man and the managers. For years the bitterest hatred existed between the members of the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen. Until lately a member of the latter organization was not eligible to membership in the former. In the West, where promotion comes quick and easy; where the fireman of to-day is the engineer of to-morrow; where the world seems wider and ideas broaden,—these narrow views found little favor. Indeed, it was the Western delegates in the convention who caused these restrictions to be removed.

There existed for years the bitterest hatred between the members of the Order of Railway Conductors and the Engineers' Brotherhood.

So cordially did they hate each other that it was almost impossible to get good service. Railway managers made no frantic effort to bring about a reconciliation between these important branches of the train service. On the contrary, I am afraid some of them rejoiced in the strife, knowing well that so long as labor warred with labor, capital would have smooth sailing.

When the Knights of Labor were in their glory, many railroad employees turned to that organization as the coming Moses. This led up to a struggle between the Knights and the Brotherhoods.

When Debs—often wrong, but always honest and earnest, I believe—conceived the idea of bringing all railroad employees together in one colossal Brotherhood, he found himself opposed by all the older organizations, including the Brotherhood of Locomotive Firemen, for whose advancement he had spent the best years of his life. Just as the different nations of the earth train their cocked cannons on the other shore, so do the various labor organizations of the United States lay for one another.

Happily, thoughtful men are beginning to regard all this as quite unnecessary, as a great waste of energy, and a change is coming. Looking back over the fields where labor and capital have fought, we see only waste, want, desolation, and death. In struggles of this kind capital gains nothing, and the best labor can get is the worst of it. The great strikes of the past twenty years, including the last bitter struggle of 1894, must prove plainly to the thoughtful workingman that he must rely mainly upon his own ability to make a place for himself in the world and to hold it.

The struggle between the American Railway Union and Mr. Pullman in the beginning, the railway companies of the country in the end, have proven two facts: to capital, that it is just as well to treat fairly and deal honestly with labor; to labor, that the country is not ready for anarchy. Few people believe that the acts of lawlessness committed at Chicago were the doings of workingmen. These outrages were committed mainly by idle loafers and criminals of every cast and from every country. Foreign workingmen, at best, appear to bring all their grievances, all their disrespect for law,—in short, all they possess that is un-American,—to America. In nearly all the labor disturbances the finger-marks of the foreigner are plainly visible. The long and lawless struggle at Cripple Creek was organized and officered wholly by foreigners, and their energies were directed mainly against one American,—self-made, so far as his fortune is concerned,—who, in the panicky winter of 1893-4, advanced nearly $100,000 to build a railroad to the great gold camp, thereby providing work for hundreds of men who were actually hungry. I find no fault with a man because he is a foreigner ; only, if he cares to live in the United States, he ought to respect the laws of the country. But, when an American journal, or news-gathering association, will interview an Anarchist upon the murder of the president of a republic, allowing him to rejoice in cold type over the death of a distinguished citizen of another country ; then, when Americans allow such a man (a murderer at heart) to live in the land,—Uncle Sam becomes an accessory, and by his tolerance encourages Anarchy.

I have seen their emblems. Here, in Paris, not more than a mile from where I write, there is a corner in the grave-yard set apart for these miserable people. The walls are all ablaze with red rings, a sort of bloody funeral harness, and on their shields, red with rust, are engraved the knife, the pistol, and the torch. It is not good for the young republic of France, with a new-made grave of a murdered president, to allow these things to hang here with their breath of danger and hints of death.

It is not difficult for one, even slightly acquainted with the history of the railroads of the United States, to pick out those that have been most prosperous ; and it is gratifying to note that those roads enjoying the greatest prosperity are generally at peace with their employees.

We have seen the unpleasant side of the employee,—how, in the past, peace seemed to trouble his mind,—and now we shall see the other side.

He is not only capable of appreciating humane treatment, but is as loyal to the company employing him, when properly handled, as the highest officer can possibly be. Cross him, and he will fight for his manager. Ask his opinion, and he will show you how far the "Thunderbird" of his line is ahead of the wretched and rickety old "Nighthawk" run by the opposition road. The enthusiasm of the earnest and industrious passenger-agent and his army of assistants seems to find its way down the line to the humblest employee.

I don't pretend to say that such is always the case. A great deal —nearly everything, in fact—depends upon the character of the higher officials. A railway manager the fingers of whose 'phone run down to the pool-rooms and the gilded palaces of painted women will have a demoralizing influence upon the employees of the road. Turning restlessly in his office-chair, ever gazing out at the window to fields which he fancies elysium, ever impatient and anxious to get away from work, to return to play, he cuts everything short, and you will find his subordinates following in his footsteps.

Take the manager who is thoroughly in earnest, honest, and loyal to the company, and his influence will be felt. It is not difficult for a manager to win and hold the respect of the employees of a railway. If he but takes the trouble, and has the happy faculty of imparting a little human kindness to every employee with whom he comes in contact, he will soon win the respect of all his subordinates. In doing this he makes his own labors lighter, and at the same time adds to the happiness of the employees and the revenue of the road. The best service can be had only when all work harmoniously and with a will. Railway employees know when they are treated decently. They know, too, that an impartial judge, commonly known as "public opinion," will pass upon their cause, and they are learning rapidly that it is not good to kick unless they have a "kick comin'," as they express it. The best of them are not great readers, but they manage to acquire more knowledge of things in general, and railroads in particular, than the average citizen does. Go and mingle with a band of yard-men who are loafing round a switch-engine, and in a half hour you will get a good bit of the history of American railroads and much of the personal history of the leading railway officials of the country. You will find, too, that, if they "roast" some of them vigorously, they praise others enthusiastically. It is always pleasant to say nice things of other people. It is pleasant to try to pick out the good things in the life of a man whom the public has regarded as bad. Jay Gould, for example. The employees of railroads commonly known as the "Gould Systems" were always sure of three things,—good wages, decent treatment, and a good check for their money the moment they earned it. This respectful consideration for his employees, which was one of the noble traits in Mr. Gould's character, has been imparted to his assistants, and is distinguishable to this day. Not long ago, during an inquiry by the government into the matter of wages of employees, the president of one of these roads was called to the stand to testify. When the venerable railroader took his place and raised his hand to be sworn, his white hair falling like a halo about his head, the United States judge looked at him for a moment, and said: "You needn't swear." Perhaps the judge remembered that in that same city—then a wild out-post of civilization on the Western plains—this man had begun his railroad career as a humble employee, and that in all these years his honesty had never been questioned, and that was sufficient.

Perhaps it was not much to take his testimony without swearing him, but to me it seems a delicate and touching compliment to this great good man. I know it is customary to preserve these little flowers for the grave, but I prefer to put this one here. It may serve as a "marker" to those who follow in his footsteps; a something to strive for; "a consummation devoutly to be sought."

I never knew Tom Potter,—never saw him,—but I know he lived and died. I remember that for a year after his death it was impossible to open one of the many trade magazines, printed and supported by railway employees, without reading a line like this: "Send something to the Potter Monument Fund." I do not know that he ever got the monument, but I know he got its equivalent,—a monument of devotion, which can only be built on the foundation prepared for it in life. It proves that in the average railroad employee there is a pay-streak of gratitude, and that ought to make up for a multitude of shortcomings. But it is not necessary to die in order to receive his respect. During the hard times in the West, caused mainly by the closing of the silver mines, a very conscientious general manager called a number of employees together to discuss the matter of a reduction of wages. There were present representatives from the various brotherhoods and labor organizations who had been sent to head-quarters instructed to submit to no reduction of wages. The manager made his case so clear—showing the delegates the utter impossibility of keeping all the trains then on the time-card running, and the folly of supposing that the owners of the road would retain him as manager unless he made some effort to reduce operating expenses to fit in a measure the decrease and still decreasing earnings—that he at once won the respect of the delegation. When these poor fellows returned to their several homes and made the result of their deliberations known, there was a great row. Some of the more ignorant and unscrupulous employees openly accused the delegates of selling their constituency to the railroad. The manager heard all this in due time, and, having faith in the justice of his cause and the humanity of man, he submitted the question to a vote of all employees, with the promise that wages would be restored at the beginning of the following year. The men voted to submit to the proposed reduction, but few of them ever knew what want and misery they saved by so doing; for, if the manager had been beaten, the force was to have been reduced, and thus many of them would have been thrown out of work entirely at the beginning of a hard winter, when all the railroads in the country were discharging men.

A less thoughtful, a less humane manager, would have ordered the reduction in wages which circumstances certainly made necessary, and created a strike,—won in the end, at the expense both of the employees and of the stock-holders. It is well to observe these things and the way they work. They all show that a straightforward, open, and honest policy will often save money for the people who have been enterprising enough to build railroads, and prevent the less learned employees—the fretful children of the rail—from running blindly into danger.

I happened to be in San Francisco when Mr. Stanford died, and I want to say a word for him. If you ask me how he managed to save twenty millions in twenty years, I cannot answer; but there was something good and gentle in his nature. Poor Mr. Stanford! Surrounded as he was with his miserable millions, with all his wretched riches, yet his going away was as peaceful and pathetic as the death of a nun. He knew, it seems, that he was going, and had selected his pall-bearers. They were the six oldest locomotive-engineers in the employ of the company. Many times he had placed his life in their hands, and now at the end he wanted these strong, brave fellows to "handle his train" on the last sad run. As usual, they did their work well, walking upright with a firm step. Their eyes were tearless, their faces calm, but, if you looked closely, you would see them trying to swallow something. It was that hurt in the throat that comes to men —unfortunate men—who are not weak enough to weep.

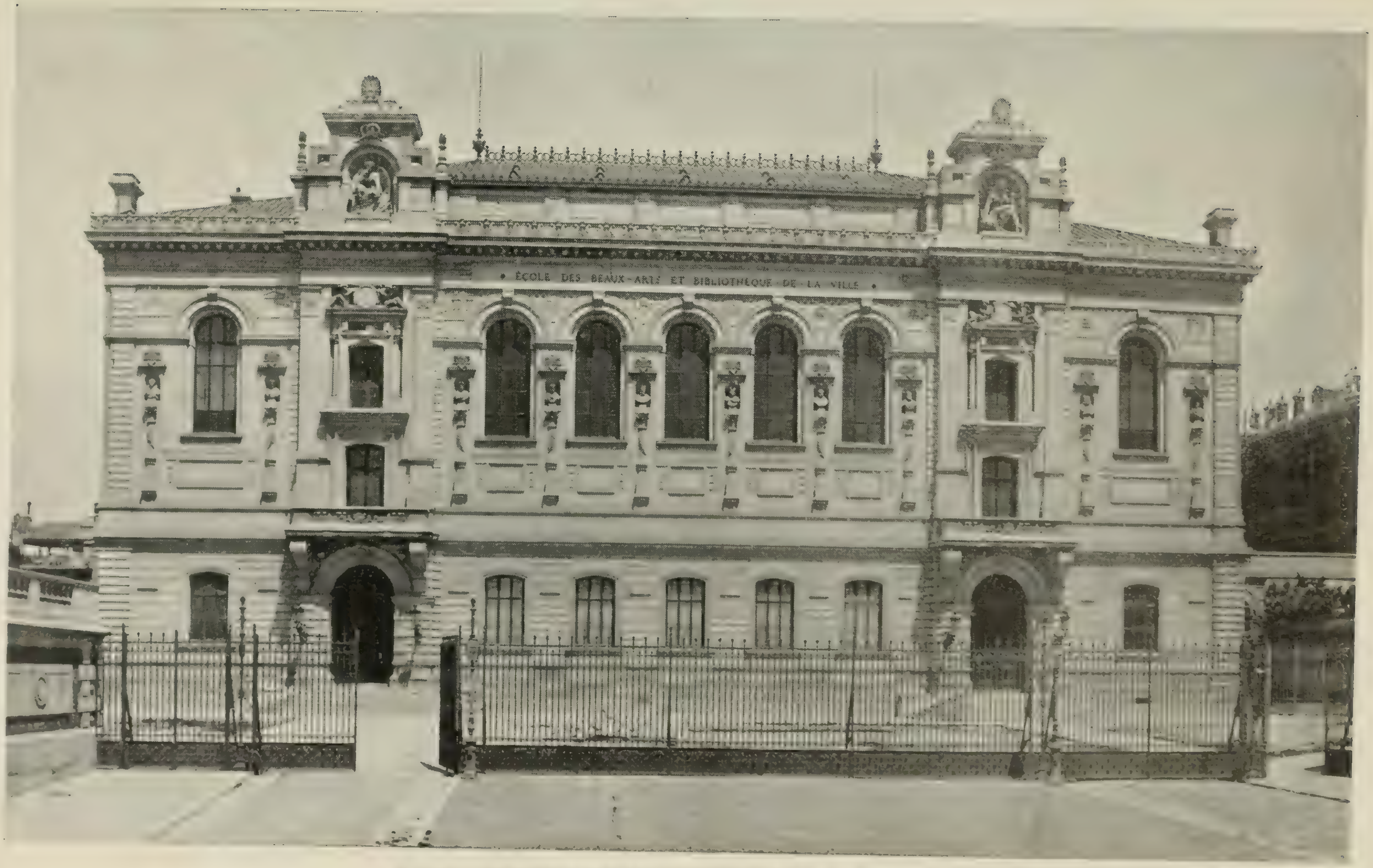
At the other end of the procession another band of employees walked with bowed heads and tear-wet eyes. Men whose homes and gods were at the other end of the earth, who found the paths at the Occident slippery ways; but they had taken something of the tenderness of their gentle master, and so walked in his wake and wept.

RECENT ARCHITECTURE IN FRANCE.

By Barr Ferree.

NO study of modern French architecture can be undertaken that does not, at the outset, acknowledge the paramount position of the School of Fine Arts in its development. The two are so closely connected that the one cannot be considered without the other. The history of modern architecture in France is, in truth, the history of the School and its teachings. The School of Fine Arts in Paris has now been doing business for nearly two hundred years. It is a respectable period of time in any country, and in France it is equivalent to many ages, if one counts by governments, since in this period more styles and forms of government have been set up in Paris, and knocked down and reset up, than the average man likes to think of, or even can keep track of. Yet through all this political turmoil the School of Fine Arts retained its individuality and spread abroad its influence, until, lo! not France alone salutes it as supreme, but every civilized land.

There was once a time, and in French history to boot, when two hundred years would have stood for gigantic strides in art. A little more than a quarter of this time sufficed, as far back as the end of the twelfth century and the first half of the thirteenth, to dot the upper provinces of France with the most glorious edifices human hands have consecrated to divine purposes ; and that, not in a single form of art, guided by one rule, limited by one standard, but in a living, vigorous art scarce more than indicated at the beginning of the period, and in the full flower of maturity at the end. It is, perhaps, scarcely fair to demand that, if French architecture produced so great a growth in one short sixty years, something kindred to this development might be looked for in a later period of nearly four times that length. It would be a grand thing and a wonderful one if it could be so, but the epoch covered by the history of the School of Fine Arts offers few points in common with the marvellous age of Philippe-Auguste. The older time witnessed the evolution of a superb architecture, not because for sixty years the master-builders of the age were intent upon a single idea and labored only with a single set of forms, but because the time was ripe for architectural development. Nothing of the sort has marked the period of the School's history. People had learned to think of other things than art ; art itself had changed its form and aspect ; manners, customs, ways of living and thinking, even the trouble of setting up new governments only to knock them down again, kept people's minds



SCHOOL OF FINE ARTS AND CITY LIBRARY, MARSEILLES.

M. Espérandieu, Architect.

HOTEL DE VILLE, POITIERS.
M. Guérinaud, Architect.

so far from art that during much of that time the greater wonder is, not that so little was done, but anything at all.

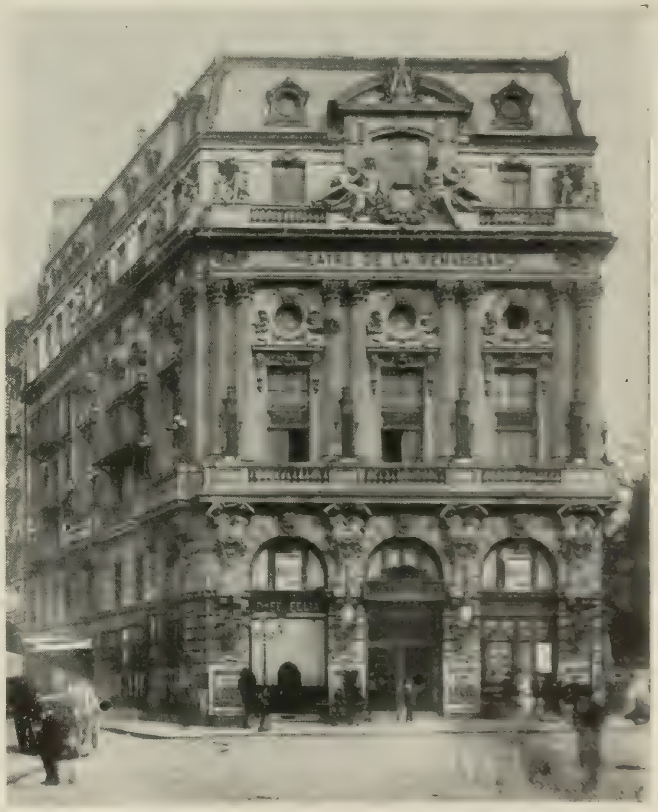
Certainly this may be said of the first hundred years, or slightly more, of the School's existence. But its position to-day is very different from the place it has previously occupied. Never before was its influence so wide, never before were its votaries so numerous, never before were its opportunities so great and so far-reaching. Had the object of its founder been to dominate the world in architecture, it might be said that at last it has obtained the place for which it was created. It does not, indeed, reign supreme; its forms are not always imitated by its followers; the whole earth is not yet filled with designs turned out in its *ateliers;* but its present position is at once so commanding, its influence so widespread, and its example so numerously followed, that the fact of its supremacy cannot be questioned.

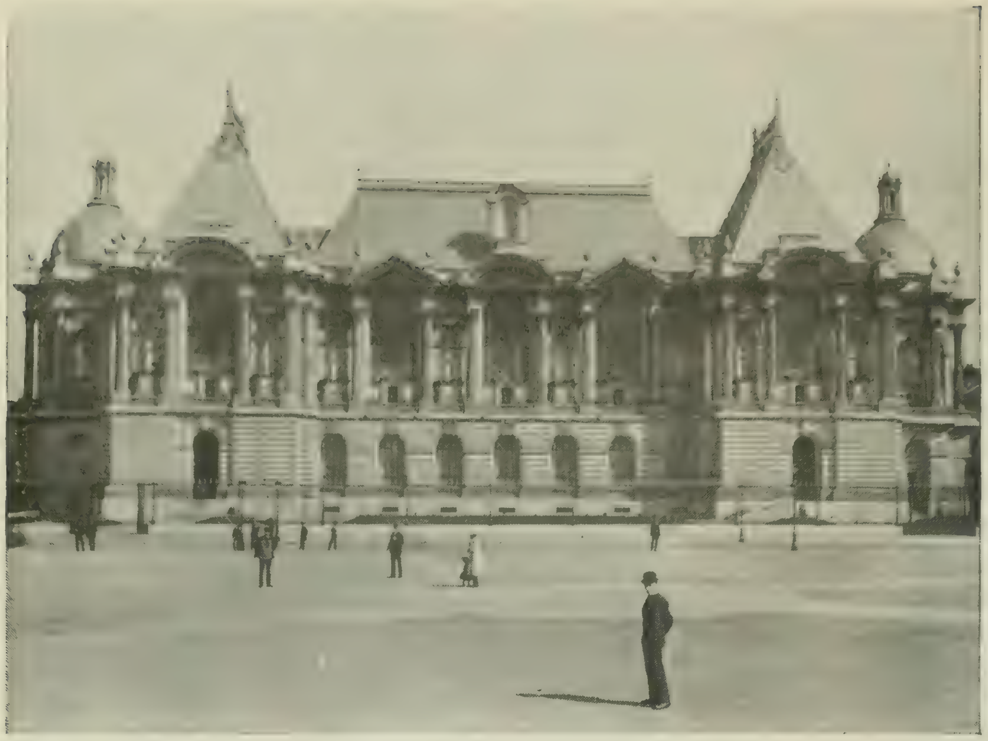
It is high time the question were asked: What are the grounds on which the School's pretensions to supremacy in architecture exist? That this supremacy is claimed; that to a certain extent it exists, since followers and imitators of the School's forms are to be found in every land,—cannot be denied. The question is not whether such a supremacy exists or not, whether it is wise or not, whether it is something we should admire or not, but what are the grounds on which it rests? Although, in the two hundred years of its existence the School of Fine Arts has not produced an architecture comparable with that developed in the reign of Philippe-Auguste, it has not been idle. Buildings of one sort or another have been built in France with quite as much frequency during its history as in any corresponding period.

The new demands of a later civilization have modified to some extent the nature of its products, but it has calmly met every problem submitted to it for solution; deliberately, if not always wisely, applied its stock features of balconies, pilasters, framed windows, and cornices to these problems; and then called upon the civilized world to admire the results. These have not been few; yet its work has consisted in but two things: in the making of designs for buildings never intended to be erected, in the solving of problems never occurring in actual practice, in the putting of lofty dreams and elaborate masterpieces upon paper; and, on the other hand, in erecting a certain number of actual structures of more or less interest. The former constitutes the actual educational work of the School; the latter forms the life-work of its pupils, and is the fruit by which it is to be judged, the end for which it has been brought into existence.

The School must stand or fall by its results and its works. That its paper designs are grander than its constructions in brick and iron and stone, and that the conceptions of the student are more sublime than the actual buildings of the architect, is perhaps not to be avoided. Pleasant dreams are apt to be pleasanter than the most delightful of earth's realities, and, if an architectural system is founded on the dream basis, it need not be wondered that its fancy flights should possess points of interest not to be seen in stern realities.

The inquiring student from America who seeks to study French architecture in its own fair land must be impressed from the very first with the extraordinary fact that it is the bad elements of the School's work that are imported by our Franco-American architects, — Frenchites is a better word, —while it is the good

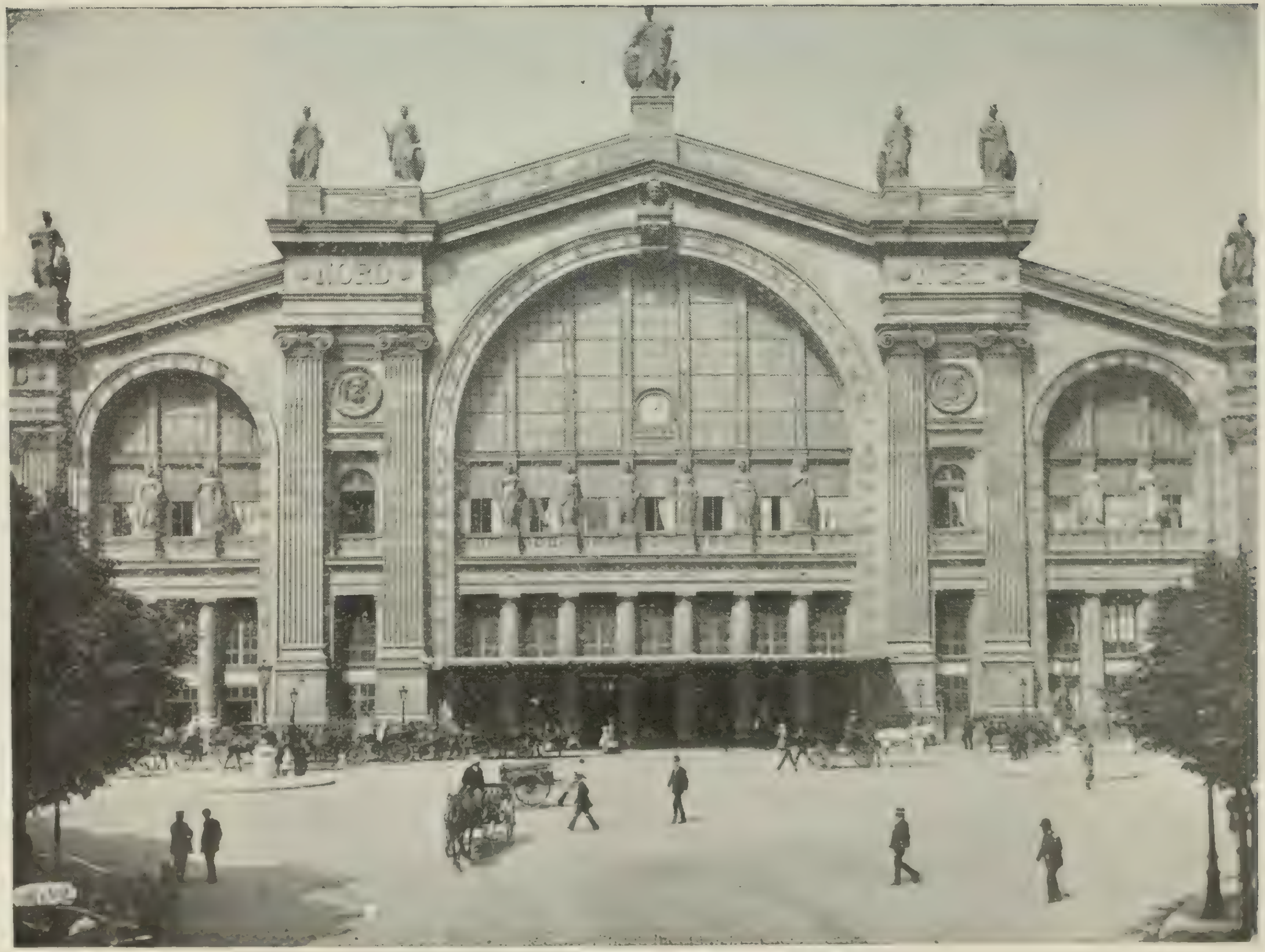

THEATRE DE LA RENAISSANCE, PARIS.
M. Carrier-Bellerise, Architect.



THE PALACE OF THE FINE ARTS, LILLE.
MM. Bérard & Delmas, Architects.

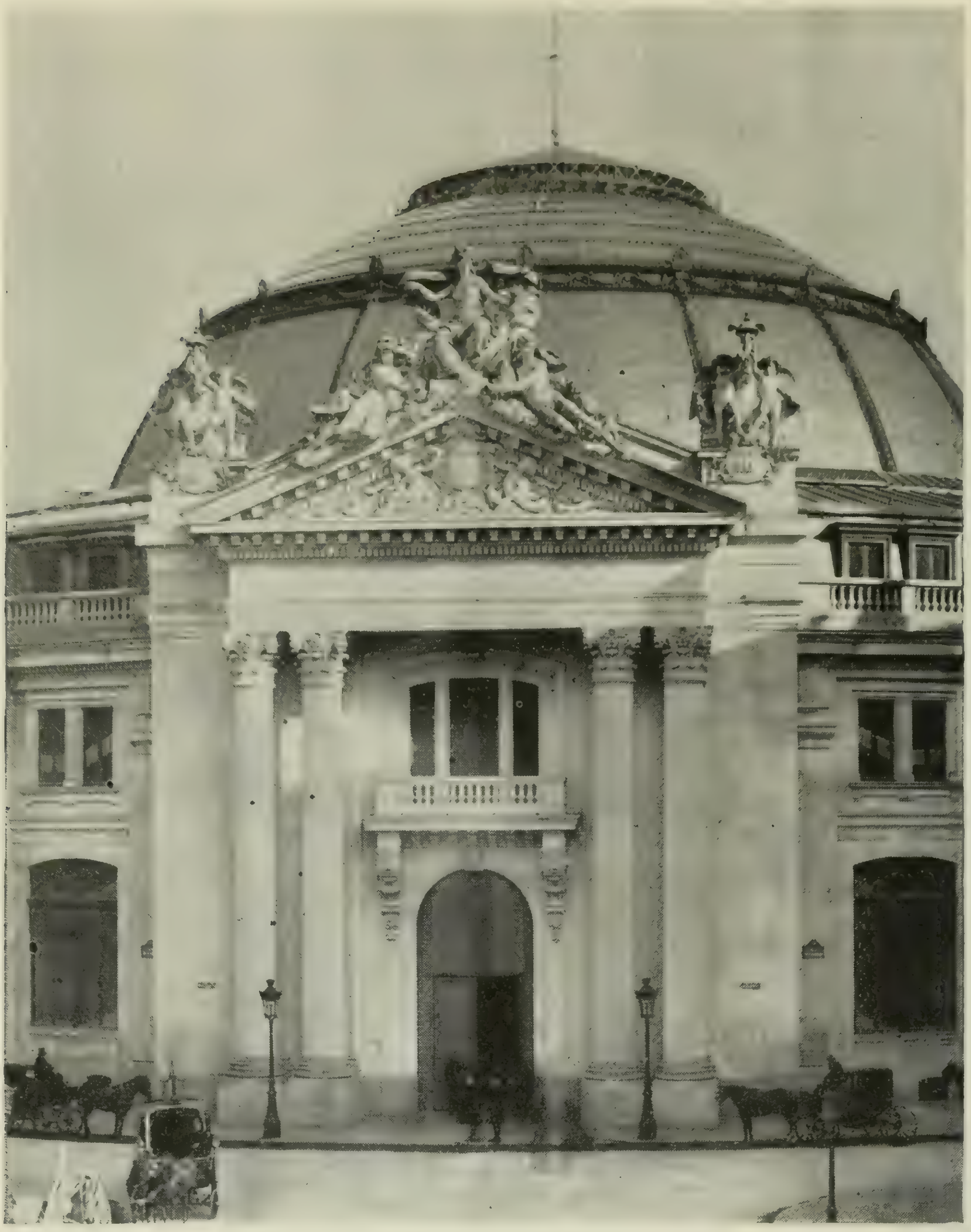
points that are generally ignored. Exceptions there are to both these statements ; yet I have been time and again impressed with many excellent features in current French work of which we scarcely hear anything in America, and certainly see nothing at all. In other words, the first lesson the student learns is that America is the worst place in the world to study French architecture, notwithstanding the fact that a large number of able architects will confidentially inform you that no man at home is worthy the name of architect unless he has studied in Paris, and the further fact that the copying of French forms, the aping of French ideas, the reproduction of French models, now amounts to an actual craze with us.

The most distinguishing characteristic in current French architecture, the element that may be seen in almost every building, the quality that may be noted in every locality, is the adaptability of the structure to its purpose. If it is a school building, it is a school and nothing more. If it is a town hall, it is as unmistakably that, and is as elaborate a piece of architecture as the appropriation made for it permits. If it is a great palace or an expensive museum, it partakes of the natural character of these structures. In business buildings alone is this nice balance sometimes lacking. If funds are short, the building is correspondingly simple ; if they are ample, it is correspondingly



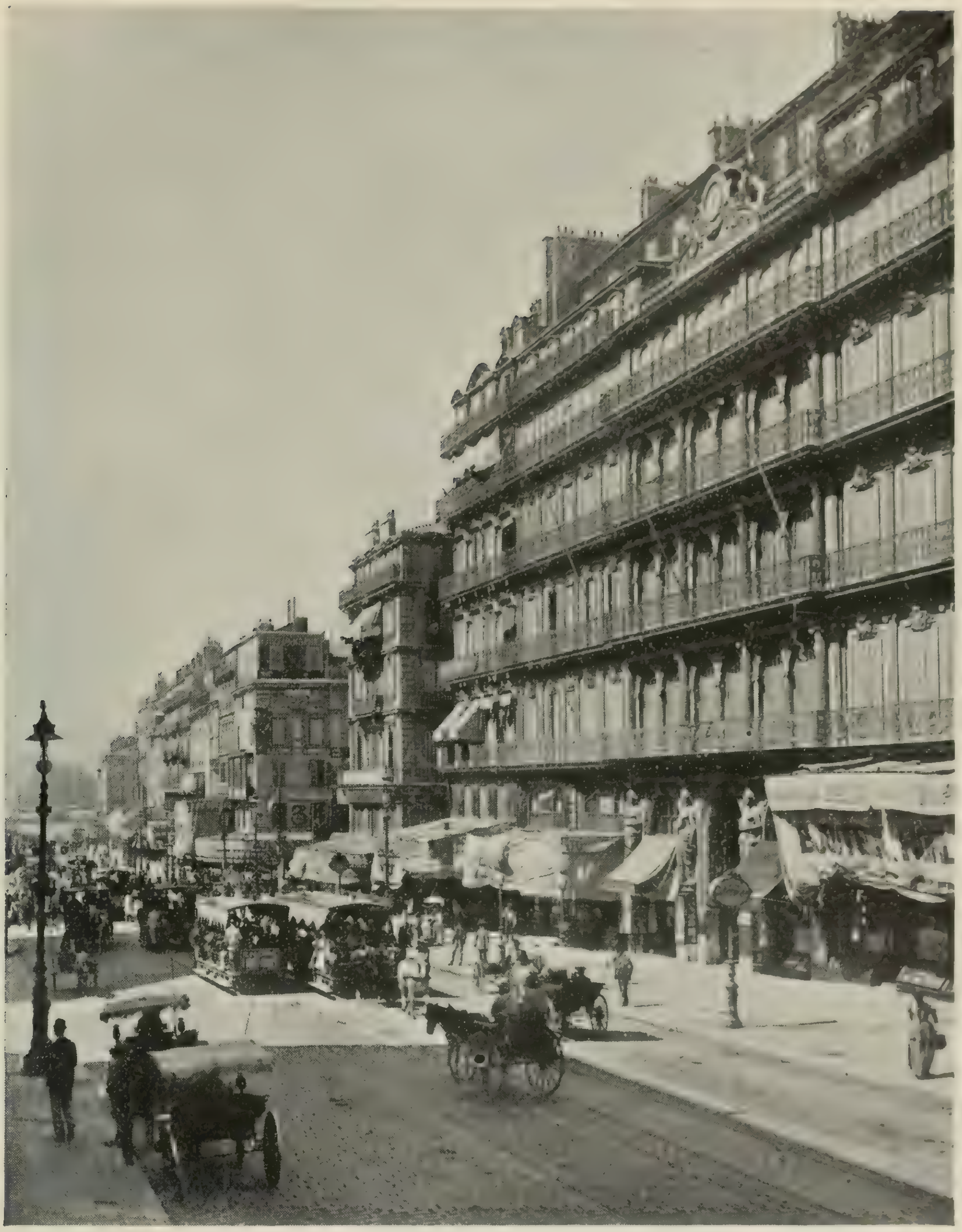
THE NORTHERN RAILWAY STATION, PARIS.

M. Hitorff, Architect.



BOURSE DE COMMERCE, PARIS.
M. Blondel, Architect.

rich. There is always a careful adjustment between funds and purpose and architecture that the people of other lands would do well to ponder over and profit by. Those American institutions—and several might be named—that have projected costly palaces for themselves with only a fraction of the necessary funds in hand are proceeding upon a principle of economics in architecture that no Frenchman would venture upon. But this is one of those common-sense pro-



HOTEL DU LOUVRE, RUE NOAILLES, MARSEILLES.

cedures in French architecture that our importers of that commodity have as yet failed to bring over.

The results of this common-sense policy are just what might be expected. The Frenchman does not build for show, unless he is able to carry out his project. He is never afraid to build simply and plainly; nor does he hesitate to satisfy himself with a plain wall, —though he will go so far as to whitewash it,—if that is all his money will permit him to do. Architectural art often loses by this

CENTRAL SCHOOL OF ARTS AND MANUFACTURES, PARIS.
MM. Demimuid & Denfer, Architects.

habit, but there can be no doubt that the French people are gainers by it. Examples of this may be seen in almost every city and town in France. The schools, of which a prodigious number have been built, are excellent types of it. Plain, simple, unpretentious, almost ugly buildings in their absolute want of artistic form, these well-planned, conventionally-designed edifices must, for all their lack of pretence, be counted among the most important and successful of modern French buildings. For, plain though they be, it is not slipshod building that they illustrate, though in America they might be spurned by the average architect and ignored by the best as beneath the notice of masters of their art. These plain walls, these severe forms, are part of the system on which the buildings are designed. Intended only as coverings and housings for the schools, it matters little what their external form may be, if their planning is judicious, economical, and wise. That is the real strength of these buildings; their façades are nothing, their plan is everything.

There is much wisdom in such a system, but it is not applicable to every sort of structure. A plan is not a building, though it is a good start and an essential foundation. But, if modern French architecture had nothing to offer but these formless schools and kindred buildings, the system under which they are produced would soon topple off its lofty perch on the apex of architectural art in the nineteenth century. We may regard the absence of architectural features as admirable in buildings where their presence would be a superfluity or where the funds in hand will not permit their use, but we require more than a plan to satisfy our conception of modern architecture as an art. Yet the disdain with which the elevation is frequently treated in these elementary structures sometimes appears in more pretentious works, for in these too frequently the façade fails to equal the plan in excellence, and students at the School make no secret of the fact that the larger part of their time is given to the study of the plan, the elevation being left until the last, when it is, as it were, pitchforked upon paper and regarded, apparently, as the product of inspiration rather than as the result of profound study and careful thought.

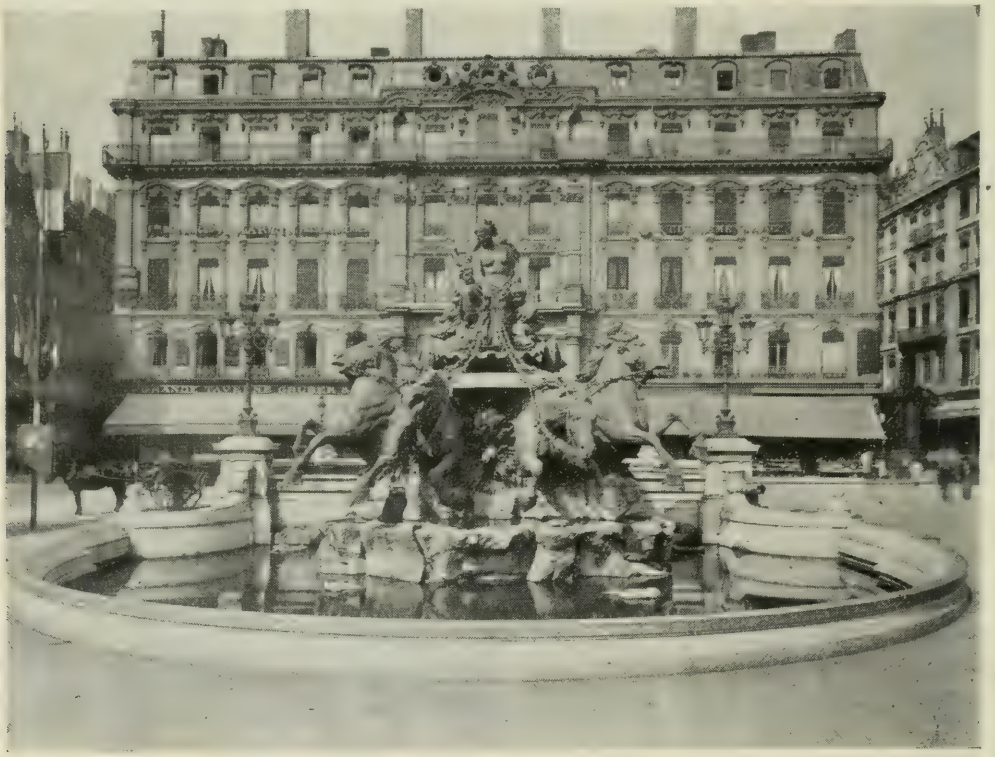
If one sees many buildings in France that interest only by their severe insistence on commercial or financial requirements,—and these are not what we call commercial buildings in America, but schools, manufacturing establishments, and the like,—one is not less astonished by the prevalence of bad buildings. For one masterpiece there are a thousand horrors,—a truly extraordinary state of things for a country which not only affects to lead the world in art, but which supports a great school of architecture for the creation, maintenance, and preservation of an architectural standard. We may look upon such a condition at home with a certain equanimity, since we can always console ourselves with the thought that we know no better. But France! Surely, if anything is admitted in modern art, it is that they do things better in France than in less enlightened countries. And yet, if all the pretentious buildings erected in France in the last twenty years could be gathered in one single exhibition,—barring such extraordinary masterpieces as the Opera House in Paris, the Palais de Longchamp at Marseilles, and one or two similarly ornate structures built under unusual circumstances,—the proportion of interesting buildings to bad, of good things to indifferent, would be found

THE NEW SORBORNE, PARIS.

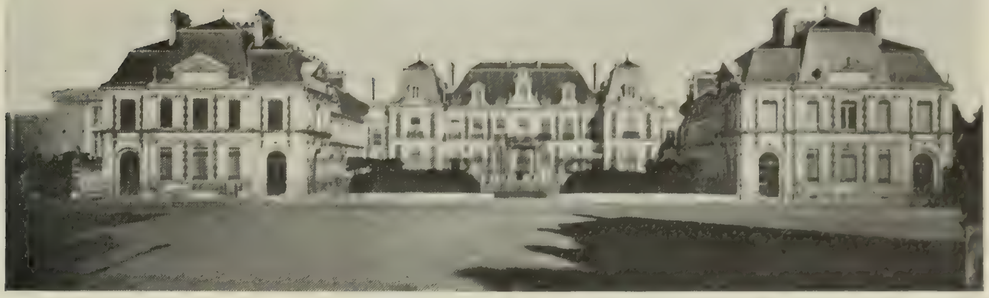
M. Nénot, Architect.

very small indeed. That this is actually so cannot, I think, be denied. That it is so relatively leads to but one conclusion,— the failure and incompetency of the School of Fine Arts to introduce an architectural standard that its pupils can carry into actual practice.

Suppose, in the list of buildings that might be considered, above the average, both by purpose and in cost, there were fifty or even a hundred ; what would that be out of the enormous total of other structures erected in the same period ? Look at the conditions that surround architecture in France. Elevated to the dignity of a department of the government ; given a costly and superbly equipped School for the training of young architects ; provided with every apparatus, given every opportunity, dowered with prizes and rich collections,—architecture enjoys opportunities in France that it has in no other land. And when to this we add the natural artistic tastes of the French people, their rich artistic past, their countless artistic monuments, their environment, their skill, their ingenuity, in very truth it would seem that the production of architectural masterpieces would be an everyday occurrence with them, while no trouble at all should be experienced in giving less pretentious structures that grace and beauty they could not have in less happily situated lands. Is it too much to ask for this ? Is it too much to look for extraordinary things when men, after all, are but human, and accustomed to mediocrity ?



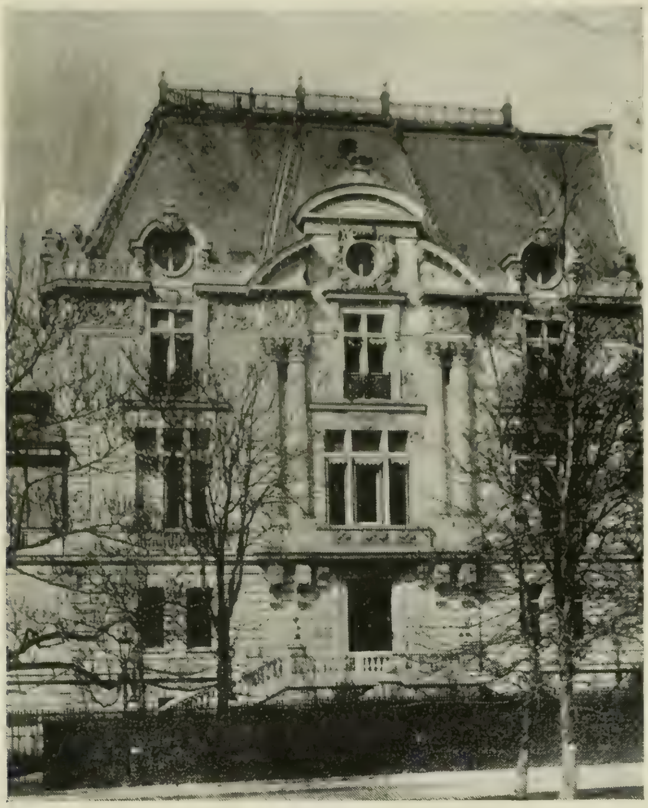
STREET ARCHITECTURE IN MARSEILLES.—THE BARTHOLDI FOUNTAIN.



THE PREFECTURE, POITIERS, COURT FRONT.
M. Guérinaud, Architect.

Unquestionably it is too much to insist on masterpieces as the solitary product of the School of Fine Arts. Doubtless it would be both delightful and elevating if such were the truth; but the history of architecture—and the history of French architecture is not an exception—shows that masterpieces are the rare gems, not common, everyday affairs. It is true this rule was all but broken during the great cathedral-building epoch in the thirteenth century, and again when the valley of the Loire was dotted with its châteaux, but those were exceptional times that have no counterpart in the present day. And it is further true that the educational work of the School is chiefly concerned with the making of masterpieces on paper, and it might, perhaps, be in order to ask that some of this skill, so abundant and so plentiful in student days, should be served up in appreciable quantities in real structures. But, while it may be true from the French standpoint that all its architects are capable of producing masterpieces, very few of them, with the opportunities of producing great buildings that occur more frequently in France than elsewhere, ever actually have the chance of doing something really great. The most they can do is something good; and it is by this they should be judged.

Did time and space permit, it would be interesting to interrupt this discussion for a little dissertation on the geographical distribution of modern architectural monuments in France. If architecture is so important an art in France that the government can support a costly school for instruction in it, there must be ample opportunities for its graduates to build and cover their land with buildings both interesting and good. Yet I have been solemnly assured by gentlemen who have made their life-work the diffusion of architectural knowledge in accordance with the French standard that it is only in Paris that notable works in architecture are to be looked for. Is it true? I trust not; I do not think so; but at least this statement reflects culti-

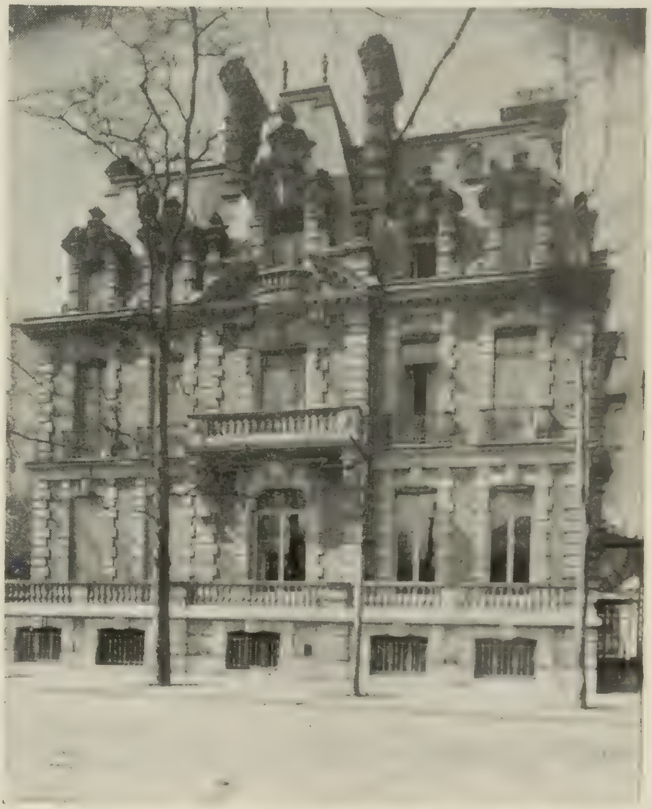


PRIVATE RESIDENCE, AVENUE BOIS DE BOULOGNE, PARIS.

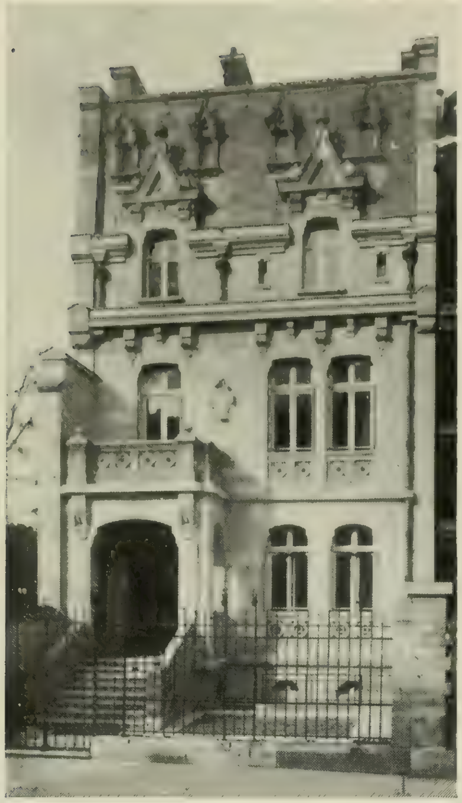
vated and trained opinion on the subject, and saves one the bother of visiting the Departments in search of modern architecture. But let us, for the nonce, accept it as fact, and study the monotonous streets of Paris.

For Paris streets are monotonous, with a deadly dullness that only London streets of the first part of the century can equal. It is a different sort of dullness; while the older London architecture is dull through lack of form and art and variety, the newer Paris architecture is dull through an affected and attempted variety. They no longer build structures as featureless as those that line in the Rue de Rivoli, or edifices as sober and thoughtful as those that form the Place Vendôme or the Place des Vosges. They do much worse than either style illustrated in these different groups. No house, no structure of any kind, is now erected in Paris that is not plentifully supplied with pilasters, apparently deemed as essential as the windows or the enclosing walls. Every floor must have its balcony carried on stone carved corbels, and railed off with light iron grilles. There must, after a certain height, be a cornice, likewise carried on corbels. And over all there may be one or two stories, an attic, and a curved roof, or something pieced on to eke out the height. And when we have put casement windows to the openings, and lace sash curtains to these, we have obtained a design in the most approved Parisian style for block buildings. It is simple enough, and, in capable hands, possible of satisfactory and pleasing treatment, but when repeated a thousand times in a single street, and on every cross street and in every part of the huge expanse of Paris, and in every modern street of every modern town in France, it becomes monotonous and sickening. Its possibilities have long since been exhausted ; the surfeited student can scarce keep back a cry for something different.

Academic training in architecture may not be directed toward such an end, but this distressing monotony is one of the results it produces. As a natural consequence there is not in all Paris a single restful stretch of wall. What is left of a front, after the windows have been cut in it, is used as standing room for pilasters ; or cornices and balconies straggle across it until, of plain restful surface, there is nothing at all. This would be bad enough, were the ornament applied to the walls good and sufficient ; but, when most of it is very bad, hard, cold, unsatisfactory detail, verging to one or the other extreme, either too coarse and florid, or too refined and small, it becomes absolutely intolerable. But the real state of things is much worse than this implies ; with all his respect for the past, with his dependence on precedence, with his ceaseless copying, his endless reproduction of past forms, a French architect is never so happy as when he is inventing a moulding or a column of his own, unless, indeed, it is when he is going further than this and is making a purely original Order. That most of these newly-manufactured additions to architectural knowledge are wanting in the very elements that make the Greek and Roman Orders good and great he does not seem aware ; for, whenever the chance occurs, he gets busily to work, turning out aberrations and doing his level best to make his work as extraordinary and as individual as he can, doubtless under the impression that he is thereby showing a vast amount of originality and perhaps some little industry and invention.


THE MODERN RESIDENCE AS IT IS MADE IN PARIS.

Recent French architecture is very largely deficient in feeling, and this arises, in good part, from the



A PRIVATE RESIDENCE IN PARIS.

hardness and inefficiency of the detail. French architects appear quite incapable, even in their most academic designs, of throwing off their academic training. Their designs want life; they are deficient in vitality and feeling. Is it due to a striving after realities which the designer himself is incapable of producing? Is it due to a lack of appreciation of these qualities in architecture? Or is it due to a simple inability to do otherwise? Possibly all things may have their influence in one way or another; but, whatever the reason, the results are clearly in evidence.

The conditions under which architecture is practised in France apparently have their influence on this use of detail. French buildings divide themselves into three general classes. In one are the utilitarian structures treated in a utilitarian manner, admirable in its severity, though not additive to the beauty of the cities. In another class are ordinary blocks of city buildings, designed almost on a single model, calling for little effort at originality or variety on the part of the designer. In the third class are the more ornamental and monumental structures with which the soul of the French architect is delighted, with which the architects of other lands are dazzled, and by which, it is to be presumed, the architecture of to-day in France is to be measured. But, while few really monumental structures are produced, the possibility of their production is present to every one. It is small wonder, therefore, that the methods to be employed in more pretentious buildings should be employed in less important ones. The richness and overloading of many French designs; the constant employment of pilasters, especially where they are not needed; the introduction of new Orders and the invention of new detail,—all these may be but a survival of the idea that every man may design a masterpiece in his day, and his application of these things to every sort of building may only be an effort to keep his hand in.

SEWERS AND SEWAGE DISPOSAL.

By Rudolph Hering.

NONE of the public works of a city have a greater influence upon the health, comfort, and safety of the inhabitants than those which supply copious quantities of pure water for domestic and public purposes, and those which remove it after use, soiled and polluted by offensive waste matter, some of which may harbor and disseminate causes of ill-health and perchance of death.

It is therefore plainly one of the first duties of city officials to have such works built and operated in the best possible manner. The result of this care does not make itself felt at once as a flow of dollars into the city treasury; it appears, nevertheless, as a priceless benefit in prolonging or saving life and increasing its comforts. Benefits are so often reckoned merely in terms of money value that sanitary advantages are not at once recognized. No wonder, therefore, that in many cases improvements in water-supply and sewerage are delayed, with fatal consequences. Sanitary science in its progress is revealing the causes of infectious disease and the means of preventing it; pointing out every day with greater precision how the enemies to our health are brought into the midst of us, are nourished and propagated by our surroundings, and are allowed to slaughter the innocent citizens who know not how to provide efficient defences. And, commensurate with this progress, greater attention is given primarily to the selection of a good water-supply and almost equally to the proper removal and disposal of sewage. The relation of cause to effect is becoming as certain in sanitary as in mechanical science. The responsibility of city officials is being more clearly outlined, and neglect to give due consideration to this branch of knowledge must draw upon them the same condemnation as neglect of law in any other branch.

It was the original plan of both my editor and myself to treat the two branches of the problem in a single paper, entitled, "Problems of Water-Supply and Sewerage." But, when I came to write the article, we found that it was practically impossible to do the subjects justice in such narrow limits. We have decided, therefore, to devote one paper to each branch of the subject; and as in the last number of the magazine Col. Waring has treated the problem of municipal cleansing, it seems appropriate to first deal with sewerage, and then in a later paper treat the question of water-supply.

Nearly all the water furnished to a building becomes polluted therein by its use, and is then called *sewage*. Its collection, removal, and disposal by pipes and other channels, together with all necessary appurtenances and other works, is defined by the comprehensive term *sewerage.* The collection and removal of rain-water or sub-soil water by the necessary works is termed *drainage.* In the subsequent pages we shall confine ourselves to the subject of sewerage, and follow the foul water from its origin within the buildings to its final disposal, considering particularly the more important requirements and a few of the difficulties sometimes met in fulfilling them, when making designs for new works or for extensions of existing works.

The subject of municipal control of house sewerage has received much attention during the last decade, with the resulting opinion that the design and execution of plumbing work should not be left to the house-owners themselves, because ignorance or wilful neglect on their part may cause injury or death to innocent persons.

Ordinances for the regulation of plumbing with reference to sewerage are of great importance to the community, the dangers from neglect to have proper appliances and arrangements for the removal of sewage being even greater than any arising from a neglect regarding appliances for the supply of water. The interaction of sewage and air circulating in the pipes, the traps and their operation, and the effects of heat and cold, make it important furthermore that the best knowledge and experience should be employed to aid the city officials in their task of enacting proper laws.

The sewage is collected in a main pipe which conveys it from the premises into the public sewer. Upon this pipe there is usually a main trap, intended to effectually prevent the air of the public sewer from entering the private sewer. Sometimes, however, it is omitted, and an air circulation established from the public through the private sewer to above the roofs of the buildings, the advantage claimed being a much better ventilation for the entire system, and therefore a better cleansing of the foul pipes.

We now trace the sewage through the public sewers along the streets of the city, down to the outfall. The designing of the system of pipes and larger channels is beset with greater difficulties than in the case of water pipes. The latter, running full and under pressure, need not be carefully graded, but this is necessary in the case of sewers, which generally should not run full, and in which the quantity flowing varies continually. Water pipes carry a simple liquid, while sewage is composed of both liquids and solids of the most heterogeneous character, some of which are liable to deposit and clog up the sewer, while others are liable to decompose and cause gases to form, plant-life to line the interior, and dangerous bacteria to find a nidus for propagation.

It is therefore necessary to pay special attention to all means that will reduce injurious effects to a minimum. The sewage must be given a regular velocity, which, if possible, should increase rather than diminish as the current advances. The least allowable velocity varies somewhat with the character of the sewage. It should always be sufficient to prevent a continuous deposition of the matter ordinarily entering the sewer. Where much sand and earthy matter, or certain heavy manufacturing wastes, are to be carried off, the velocity in, and therefore the slope of, the sewer must be greater than where only ordinary domestic sewage is to be removed.

Foulness is largely caused by a rough interior surface which retains matter. Formerly it was thought proper to build sewers with roughly-hewn stone walls, and sometimes even upon a bed consisting of the natural earth. Now the stones must be well dressed, the brickwork must be of the best, and all mortar joints must be carefully made smooth. The alignment of sewers should be made so that, if they are too small to be entered, it will be possible to sight through them from one point of access to another. At one point a lamp is held with a reflector ; at the other the observer stands with a mirror, by which the light passing through the entire length of the straight pipe is reflected into his eyes and reveals deposits or obstructions. In small sewers all changes of direction are made by short turns inside of the manholes from which the inspection is made.

It has also been found that much of the foulness arises from improper junctions of sewers, or whenever the cross-section of the flowing sewage abruptly changes. Therefore attention is now given to proportioning them properly, giving them suitable curves and shapes, so that all eddies and irregularities in the flow which might cause retardations and deposits may be prevented.

The proper size for the sewers is of course a very important element in the design, as not only the efficiency, but also the cost, of the system is materially affected thereby. If too small, the sewers fail to perform their duty, and, if too large, their cost is excessive. The smallest size is not governed by the quantity of sewage to be admitted, but by the size of solid substances that find their way into the pipes. Practical experience, not theory, must guide us therein. It has been found advisable, both in Europe and America, after perhaps half a century's experience, that a public sewer, except on steep slopes, should not be smaller than 8 or 9 in. in diameter, on account of the frequency of stoppages when the sizes are smaller.

Where sewage alone is to be admitted, the pipes should be of sufficient capacity to carry the sewage entering them during the forenoon, when, as a rule, the greatest flow is observed. The quantity usually assumed is the same as that of the water-supply furnished the inhabitants, adding, in some cases, a percentage for the ground water which is liable to seep into the sewers.

When rain-water is admitted, it is necessary to determine various elements in order to enable the engineer to proportion every part of the system most economically,—such as the intensity of the rainfall, the imperviousness of the surface, and its superficial character and slope.

The ventilation of sewers must be given due attention, so that currents of air will reduce their foulness and that the ever-changing quantities of sewage will not subject the superincumbent air to pressures that are necessarily communicated to all the house-traps, thus possibly destroying them as such. The most common method is by means of shafts, or so-called manholes, extending up to the surface of the street and having perforated covers. But, in climates where these are likely to be obstructed with snow and ice, other means are generally required, among which that of ventilation through house sewers, previously mentioned, is sometimes favored.

Even where the sewers are supposed to be self-cleaning, it is necessary to have means for creating a stronger current than the ordinary one, so as to flush out the deposits that invariably occur. For this purpose we have at the head of the small sewers flush tanks operated automatically, or by hand when necessary, so that several hundred gallons of water may be released within a few moments. Along the line of the sewer we have man-holes arranged so that they can be used as flush-tanks, or we have swinging gates, by which the flow may be temporarily stopped and stored and suddenly released, thus cleaning long stretches.

One of the essential general questions which city officials are called upon to decide is the character of the system in respect to the admission or exclusion of rain-water. In early times the principal reason for building sewers was to remove the rain-water from the streets and yards, and even now this is frequently the case ; yet, owing to the general advancement of sanitary science, the necessity for the prompt removal of foul water is becoming equally apparent. In England, the mother country of public sanitation, we find the earliest examples of modern sewerage represented in its different systems,—the "combined" system, where both sewage and rain-water require underground removal, and the "separate" system, where the foul water alone requires it, and where rain-water can be left to flow away in natural channels or in less expensive artificial ones.

From a sanitary standpoint no difference between these two systems has been found. Theorists have endeavored to manufacture opinion in favor of the "separate" system in this respect, but statistics have not sustained them. The cleanest and least odorous sewers at the present day, so far as my own observation goes, are found in the "combined" system as built in some of the European cities.

Time has demonstrated, in England and elsewhere, that choice between the two systems must be based on the questions of convenience and cost.

The "separate" system is not necessarily cheaper or simpler. When all rain-water must also be removed underground, the expense is usually greater, and the double system then required is more complicated than the "combined" system. The reason why the latter is used more in Europe than here is that it is desired to promptly remove the rain-water from the streets.

In America the application of the "separate" system is more extended for two reasons: one is that our rainfall is more intense than in Europe, and therefore a "combined" system is rather expensive for a small community; the other is that in many small towns sewage removal is more imperative than underground rain-water removal.

The difference between the two systems is not a radical one, as the proportion of rain-water admitted to the sewers varies. We have cases where about one-half of the entire quantity, and others where only roof and yard water, or where roof water alone, wholly or partly, is allowed to enter for flushing purposes. Finally, we have a complete exclusion of all rain-water, where, either on account of pumping or purification works, the admission of any would materially increase the expense. The most extensive instance of this kind is found in the North Metropolitan sewerage system of Boston and vicinity.

Memphis, Tenn., was the first large city in which complete exclusion was adopted, in a system built and patented by Col. George E. Waring, Jr. In extending the system to the suburb Chelsea, the local authorities adopted the regular separate system, based upon principles laid down by English engineers.*

The Shone system, as built in the World's Fair grounds at Chicago, likewise excluded all rain-water. The peculiar feature of this system, however, is the lifting of the sewage by compressed air at frequent points by so-called ejectors, whereby, under certain conditions, special advantages are obtained.

New Orleans is now constructing the regular separate system according to a design made jointly by Mr. George G. Earl, as chief engineer of the work, and the writer, as consulting engineer, in which a small amount of rain-water may be admitted when desired for flushing.

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*Biennial Report of the Taxing District (Memphis), Shelby County, Tennessee, January 1, 1889.

The selection of the particular system and the proportion of rain-water to be admitted depend therefore on local and economical, but not on sanitary, requirements, and the selection should be carefully made by a competent engineer. Not only do different localities require different treatment, but in the same city or town we may have several systems working together. The upper blocks of a sewerage area necessarily exclude the street water. In a valley we may have the "combined" system and on a ridge the "separate" system. Again, an intercepting sewer may carry away the ordinary flow of sewage to a suitable place for treatment, while the storm water and diluted sewage may run into a stream.

It is therefore evident that care should be taken to adopt the best designs and contrivances for each particular case, irrespective of opinions advanced by the promoters of patents. Further, general plans for a complete system should be made early in the life of the city, so as to prevent inconsistencies and unnecessary expense later. The execution of the work and its adaptation to special requirements should keep pace with the growth of the city.

In conclusion, a few words may be said regarding the final disposal of sewage. When it can be accomplished safely by a direct discharge into a large river or the sea, this will generally be the most satisfactory mode, as, for instance, in New York, Boston, Philadelphia, New Orleans, and many other cities. When the sewage must be purified before it is discharged, we must then decide what method should be employed.

The purification can be made partial or complete, according to the requirements of the case. Complete purification can be obtained by intermittent filtration through sand of proper grain and depth. We have a number of cases where this method has been successfully employed for some time in England, France, and Germany, and we have lately commenced to use it in America. Through the excellent work undertaken by the Massachusetts State Board of Health, we have been placed in a position to design such works more intelligently and to better effect. They have ascertained the fundamental elements affecting the questions to be considered, and have given us data showing, for instance, that sand is better than soil; that the size of the grains and the quantity of sewage periodically applied stand in a definite relation to the degree of purification. We know better than before what effect a constant use of the same filter has upon its usefulness, and what means are necessary to make it permanently effective in winter and summer and from year to year. From the best filtering areas, both in Europe and America, we obtain thoroughly purified sewage,—purer than some waters furnished for domestic consumption.

There are many instances where clean sand, the most suitable material for purification, cannot be had in sufficient quantities, and then we must be content to partially purify, or merely clarify, the sewage. This is done by mixing with it certain chemicals, notably lime, salts of iron, or alumina, by which the suspended and some of the dissolved organic matters are precipitated, leaving a clear liquid to run off. But these methods still leave about one-half of the organic matter therein. Many such cases of chemical purification are found in Europe, and in our country we can name Worcester, Mass., and the World's Fair at Chicago as the best instances.

What system of disposal to select, particularly when a sufficient quantity of the proper sand cannot be had, is often a difficult question. The expense of precipitation is often a serious objection to its use, and the cost of a long outfall sewer to some large water course, where a discharge is permitted without purification works, may also be great. But, whatever may be the expense, a proper solution should be found, and it may be well to consider that the time is certainly approaching here, and has already arrived in some European countries, when sewage must be purified before it is discharged into a stream. Therefore no plans for a sewerage system should be adopted without due consideration of a *future*, as well as a *present*, proper disposal of the sewage.

PAVEMENTS, SIDEWALKS, ROADS, AND BRIDGES.

By Major J. W. Howard.

CITIES, States, and nations are organisms which grow and improve in proportion as they care for their moral, mental, and material welfare. Their success depends upon the engineers directing their constructions as much as upon their teachers, law-makers, and merchants.

Engineering, in a broad sense, covers all constructions where materials are combined in various forms for various purposes. This profession has existed for more than 6,000 years, as is shown by the Pyramids, obelisks, and ancient canals of Egypt. The walls and terraced hanging-gardens of Babylon, built later, show the growth of engineering science. The aqueducts of Rome, with their tiers of arches, are also its monuments.

Roads and bridges appeared simultaneously with other great engineering undertakings. No one can read about the Via Appia and other highways of the Roman empire reaching over Europe, carrying military and commercial power, law and order, throughout the then known world, without respecting the engineers who laid these lasting foundations of modern civilization. Of such importance did Cæsar deem the construction of a bridge over the Rhine in 55 B. C. that he described it so minutely that a modern engineer could easily reproduce it. Where traffic became concentrated near and within a city, the Romans recognized the necessity of using stable materials for the surfaces of their streets. They early discovered that increased first cost diminishes cost of subsequent maintenance,—a fact which is the keynote of economic paving.

We realize the great problems engineers have had to solve in providing for the safety, prosperity, and health of the public, so enormously increased in numbers since the time of Columbus. Europe's population has grown from 50,000,000 to 380,000,000, and that of the Americas from a handful of colonists to 126,000,000 people. No works have been more important or vitally necessary than the streets and highways facilitating intercommunication, so necessary to the very existence of civilization. This importance may be realized by reading Bergier's "Histoire des Chemins Romains" (History of the Roads of Rome), or by consulting a few of the many works on this subject published at intervals by able engineers since 1547.

The French early recognized the construction of bridges, roads, and streets as a special science, and established more than a century ago their renowned École des Ponts et Chaussées, whose graduates have sole charge of the roadways and bridges of France and the pavements of her cities. The results astound a visitor the moment he enters that country.

The progress of American roadways and street-pavements has been slow, with a few well-known exceptions. The history of these constructions in America can be divided into three periods: first, ignorance and apathy,—a state of affairs found in many communities, especially where the people have never seen well-built streets and roads; second, empiricism or rule-of-thumb, influenced by conservatism and habit, which keep bad pavements, sidewalks, roads, and bridges in many communities for years; third, good engineering construction. Many States, counties, towns, and cities have awakened to the economy and benefit of properly-constructed streets, roads, and bridges, and are acting accordingly. But there are still many cities which, because of unattractive, rough, noisy, dirty, and poorly-paved streets, repel successful and wealthy retired people, to the social and financial detriment of the place. Washington obtains many of its best permanent citizens because of its handsome, well-paved streets.

The paving of streets and the building of roads and bridges are too often entrusted to the care of men who lack long, careful, and special training, and who have been either unwilling or unable to investigate, inspect, tabulate, and profit by the experience of their predecessors and of men elsewhere. City after city, after much difficulty, a long struggle, strong opposition (usually political), and costly experiments, has taken pavements, water-works, sewers, etc., out of ignorant, apathetic, or political hands, and placed them in charge of men who apply scientific methods, and who profit by the recorded experience of other cities. The results do credit to the cities, their mayors, and administrative officers, as well as to the engineers.

The experience of a city in paving should be recorded and tabulated from year to year, and thus become cumulative. The short terms of office too often allotted to city engineers make tabulated experience the more necessary. A public official who makes public experience a private matter does wrong; he will be a failure. If he neglects to properly analyze and record in official books the cost of work under his charge, such as the first cost and maintenance per square yard of the different kinds of pavements, he cannot demonstrate what he has really accomplished, nor will he be appreciated and receive the final benefit.

The materials which each city or county must use in the construction of its streets and roads are often largely governed by local conditions; but how these shall be employed, and whether or not it is best to bring better materials from a distance, can only be decided by an engineer familiar with roadways and pavements. Each community should constantly or periodically employ a competent engineer for paving and road-construction. He would save to the city far more than his compensation, and produce better results.

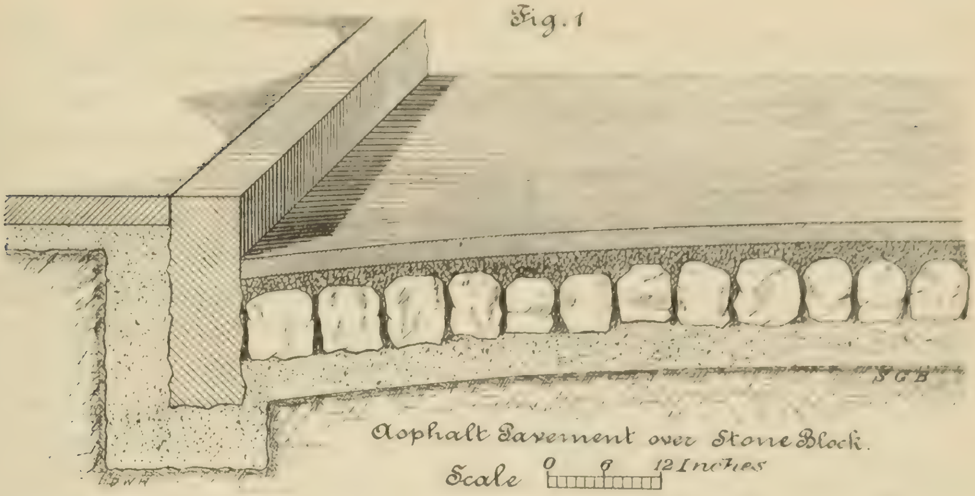
The question of cost of pavements and roads is a relative one. Prices of the same kind of pavement or class of roadway are not the same in all places. True economy considers not only first cost, but maintenance also. It takes cognizance of other expenses depending upon pavements, as cleaning, sprinkling, and indirect private expense of citizens arising from the cost of traction and transportation of persons and merchandise throughout the city. We must study the cost of repairs to vehicles and harness, the number of horses needed and the wear upon them, weight of loads, effects of dry, wet, hot, and cold weather, and of the dust from the street which affects our health and possessions.

In order to have a standard, it is well to define a theoretically perfect pavement.

A perfect street-pavement would provide a surface for the easy passage of vehicles. It would offer the least resistance to traction consistent with a foothold for horses. It would be easily cleaned; it would be impervious to moisture; it would retain no filth within it, and produce from itself no odor or dust; it would be as noiseless as possible, and otherwise of sanitary value. With it there would be no jarring, either of vehicles passing over it or of adjacent buildings. It would be as durable as is consistent with the necessity of continual, quick, and easy repairing of its surface. It would be made of material that can be cut through and firmly renewed over gas and other pipes. It would be so laid as to be easily and quickly drained. It would be such that it could be crossed on foot at any point.

All good pavements consist of a foundation, or support, and a wearing surface. If durable foundations are not used, the wearing surfaces soon become uneven from frost, heavy traffic, or settlements. The best foundations for the pavements of large cities are made from concrete. They should be six inches thick for heavy traffic, and at least four for the lightest traffic. Concrete is usually made by uniting one part of an American hydraulic cement, two of sand, and four or five of stone, thoroughly mixed when wet. The stone should be crushed to less than 2½ inches in size. A good concrete can be made by experienced men from one part of cement and six to seven parts of gravel, free from loam. Another foundation is that of crushed

Fig. 1



Asphalt Pavement over Stone Block.
Scale 0 6 12 Inches

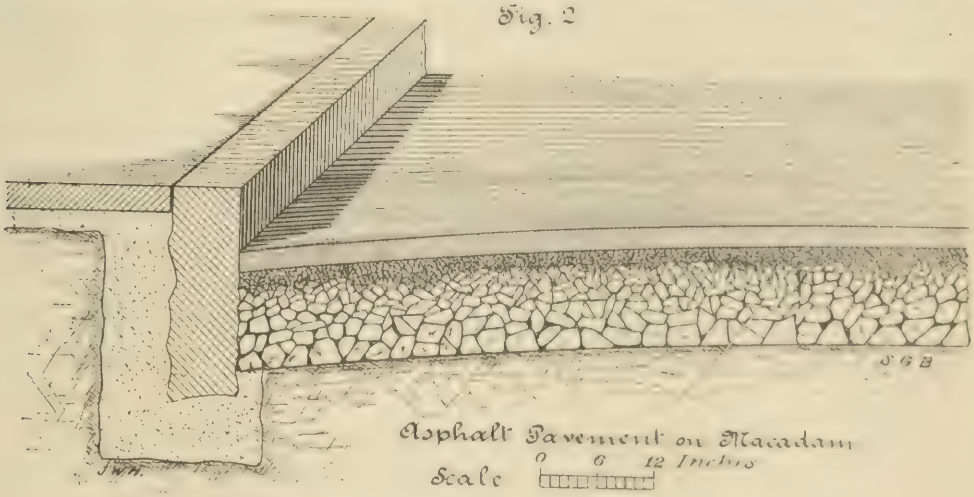
stone coated throughout with an asphaltic cement; it can be rapidly laid.

Old stone-block, brick, cobble-stone, telford, macadam, and gravel roadways are largely used for a foundation, especially for asphalt pavements (Figs. 1 and 2), by first covering the old pavement with a fine bituminous concrete, called binder, made from crushed stone 1 inch and less in size, heated and mixed with a bituminous or asphaltic cement. The binder is spread to a minimum depth of 1½ inches, bringing the old pavement to an even surface preparatory to laying the asphalt pavement upon it.

The wearing surface, be it asphalt, stone, brick, or other material, is placed upon the concrete or other foundation to receive the wear of traffic, and make possible repairs to the surface which will not disturb the foundation.

There is no everlasting paving material. No pavement should be

Fig. 2



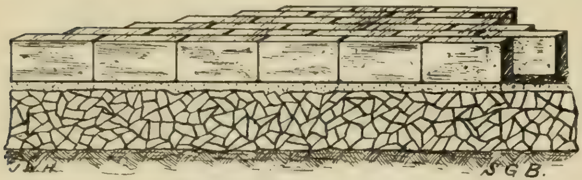
Asphalt Pavement on Macadam
Scale 0 6 12 Inches

left upon a street until worn beyond repair. Modern practice compels contractors to maintain their pavements in good order from 5 to 20 years, which is possible where the foundation remains undisturbed and the wearing surface is kept in repair. This is the cheapest as well as the best way to provide a city with good pavements.

The materials used with more or less success for pavements are, alphabetically, as follows: asphalt of different kinds, qualities, and mixtures, laid without joints; asphalt blocks; asphalt imitations; basalt blocks; boulder stones; bricks of various kinds; coal-tar or gas-tar compounds; cobble-stones; dolerite blocks; granite blocks; hill stones; limestone blocks; quartzite blocks; sandstone blocks; syenite blocks; scoria or furnace-slag blocks; trap blocks; wooden blocks of various kinds and shapes.

I omit telford, macadam, and gravel roadways,—to be described later when we turn our attention to roads, for they are not city pavements. They belong to parks, suburbs, and country roads. If used under city traffic, macadam, telford, and gravel become ruinously expensive, because of continuous repairs. They are unhealthy within a city, because their dust spreads and carries disease-germs everywhere.

Fig. 3



Brick Pavement.

0 6 12 Inches
Scale

The following materials are to be avoided, as a rule, for the wearing surfaces of city pavements: cobble, boulder, or hill stones, which make noisy, uneven, unsightly, and unhealthy pavements; sandstone, with a few doubtful exceptions; trap, dolerite, or basalt blocks, because they cannot be made into even, regular blocks, pavements made from them being at first rough, and the blocks afterward becoming rounded and polished, like cobble-stones.

Artificial blocks, embracing wooden ones of various kinds and shapes; asphalt blocks made from crushed stone cemented together with asphalt; bricks of ordinary clay, fire clay, shale, or some combination of these, mixed, prepared, and burned according to various systems good and bad; and blocks moulded from furnace-slag,—are to be used only after due investigation as to their quality, uniformity, strength, and the conditions of traffic and climate to which they will be exposed.

Asphalt blocks and a few brands of paving-bricks (Fig. 3) of certain clays and shales (alone or mixed) have been used, especially upon concrete foundations and under light traffic, with success.

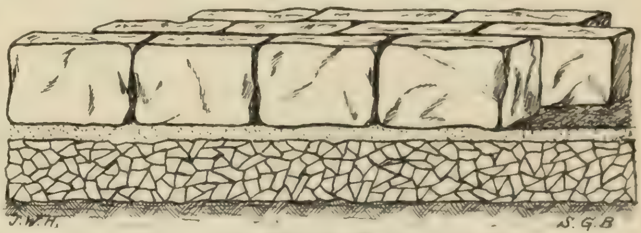
Paving-bricks vary so much in composition and quality in different localities that it is difficult to determine in advance whether the pavement will be good or bad. Caution is necessary in introducing paving-brick as an economic, permanent paving material in large cities. It is probable that a few brick manufacturers may succeed in standardizing the quality, form, and size of paving-bricks, and thus produce definite, reliable, and economic results. In brick paving the best is certainly the cheapest.

Coal-tar, under whatever name, alone or in mixtures, must not enter into the wearing surface of pavements. Under the name of vulcanite it has entered some cities to their cost.

Wooden-block pavements in this country serve as a temporary street-covering during the first decade or two of a city's existence, provided wood is cheap and obtainable in large quantities. Eventually heavy traffic and the administration of public health and finances compel the adoption of better materials.

The wooden pavements upon certain streets of London and Paris are laid upon concrete foundations. The blocks, of selected wood, cut to true parallelopipedons, are laid with great care. These pavements are constantly watched and repaired, the entire surface being gradually renewed, under heavy traffic, within four years, and, under lighter traffic, within six years. The cost, including maintenance, amounts to the enormous sum of from $6 to $12.72 per square yard,—a price no American city would pay for this form of doubtful luxury.

Fig. 4



Granite Block Pavement

Scale 0 6 12 Inches

The materials mostly used in successful wearing surfaces are certain granite, granitoid, syenite, and quartzite blocks (Fig. 4). Experience is the best guide to the quarries furnishing the best blocks. Transportation is so expensive that certain quarries are not available for serving some cities. A few kinds of asphalt pavements have proven of much value. Washington, Buffalo, Philadelphia, New York, and some eighty other cities in this country, as well as the great capitals of Europe, demonstrate the advantage of good asphalt pavements.

Asphalt pavements are laid in a continuous sheet upon a prepared foundation, either concrete (Fig. 5) or a previous pavement of old stone block or other material. These asphalt pavement surfaces are composed either of a natural asphaltum compounded with sand and a little limestone dust, or of a natural asphaltic limestone pulverized and then compressed upon the street. Asphaltic sandstone has not yet succeeded as a street-pavement. Experiments are in progress which may make it possible to use with good results this asphaltic material compounded with a little refined asphalt and asphaltic limestone.

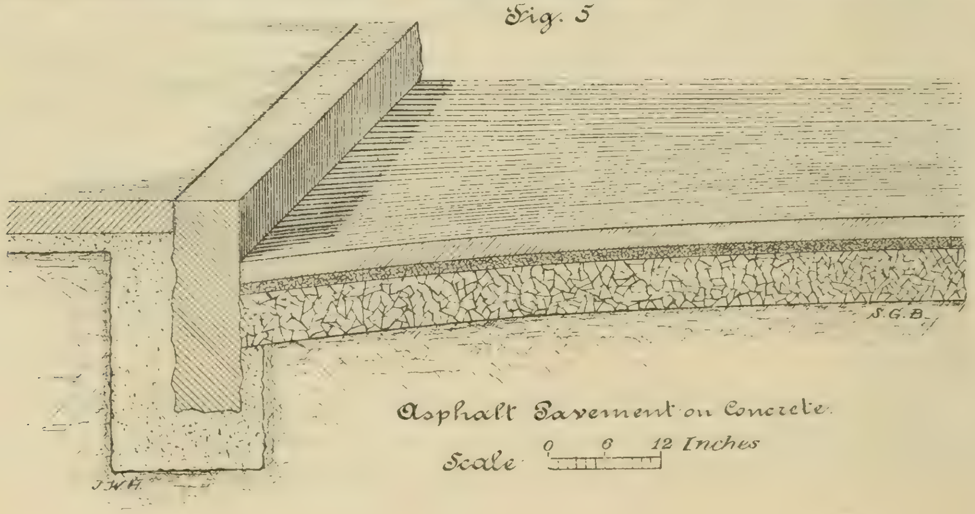
The three asphalt paving materials which at present are the most successful are the long-established Trinidad asphalt and the newly-introduced asphalt from Venezuela and California. The European material is, with a few exceptions, asphaltic limestone.

Specifications describing in detail how different kinds of pavements should be laid can be had free, upon application to the department of works or city engineer of any large city. It is a good plan for a city to distribute freely to its newspapers and prominent citizens copies of the specifications for pavements. There is no greater check upon dishonest or incompetent work, no greater assistance to an honest administration.

City sidewalks and suburban footpaths are not generally constructed with that uniformity of alignment and good material which characterize them in a few communities. Near cities, towns, and villages it is wise to construct a raised footpath on one side of the road, separated from it by rough curbstones or large stones embedded in a row, a paved gutter, or a simple macadamized depression.

City sidewalks cannot receive too much attention. The first requirement is a good curb or border-stone (Figs. 6, 7, 8, and 9), set upon a concrete or brick or sand support so firmly that neither vehicles or frost can displace it. It is a mistake to have the curb rise more than 4 to 6 inches above the gutter. A shallow gutter compels good street-cleaning. It facilitates crossing the street on foot at any point. Deep gutters are not necessary for storm-drainage. A city which can

Fig. 5



Asphalt Pavement on Concrete.

Fig. 6

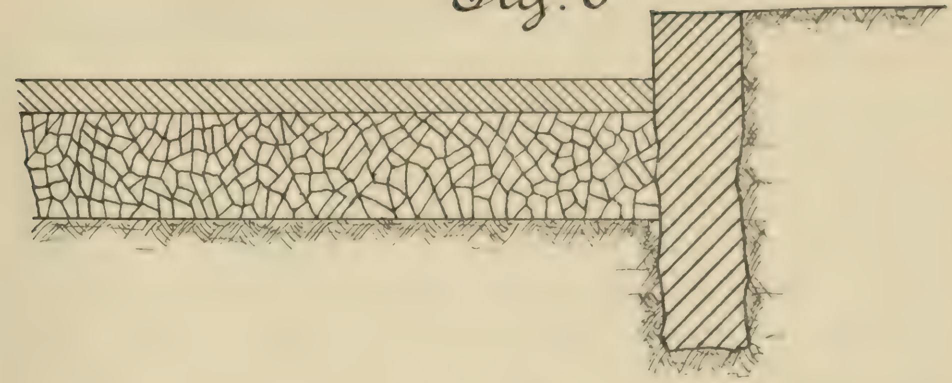


Fig 7

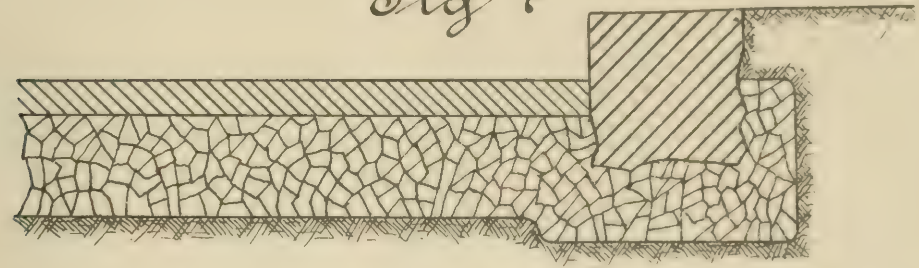


Fig. 8

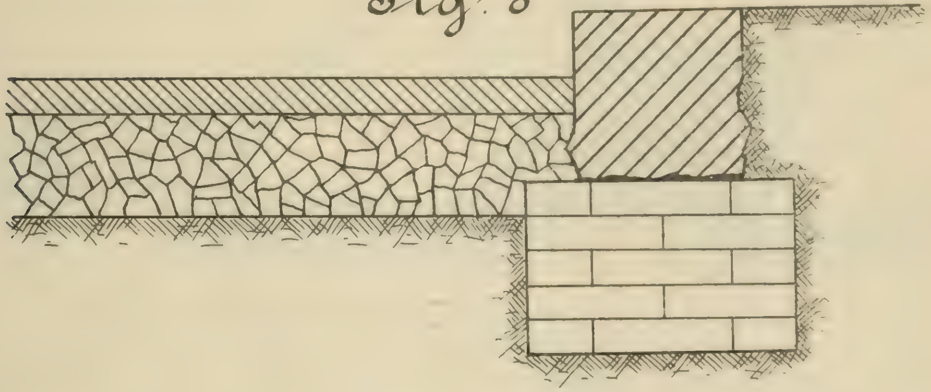
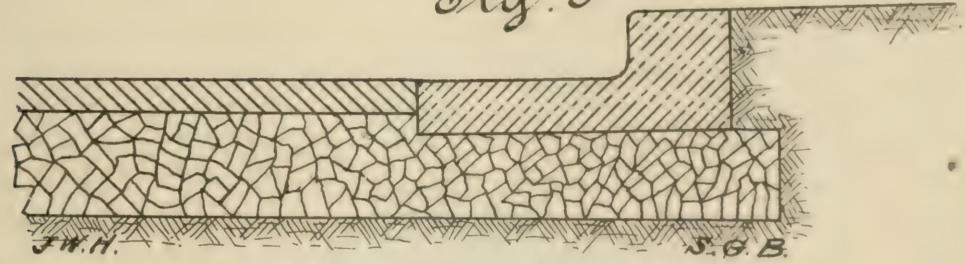


Fig. 9



Various Street Curbs

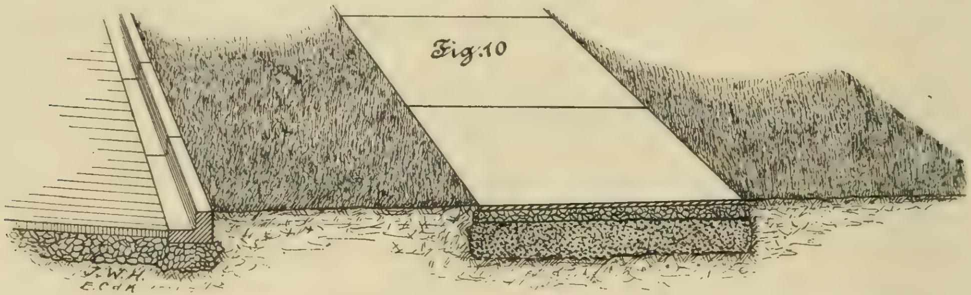
Scale

pave can have storm-sewers. The vertical face of the curb should form an angle with the street-pavement. The pavement of the street should not be rounded up toward the curb with stone or other material, as on some streets in Chicago, Omaha, and elsewhere. This makes an unsightly, inconvenient gutter,—one that cannot be kept clean.

The best sidewalk materials are carefully cut, large, flat pieces of stone, well embedded upon sand, deep cinder (treated with cement), or concrete foundation. The stone can be either granite, certain bluestones, or a very few kinds of sandstone. Limestone must be avoided. Portland cement, combined with crushed granite or other sharp, fine grit, is used with perfect success for city sidewalks. A solid foundation is absolutely necessary to the success of these artificial (cement) stone sidewalks (Fig. 10). The proper proportion of the surface is one part of the best cement and one or, at most, two parts of grit.

The enactment of a sidewalk law, or even a more strict application of existing laws on the part of our city administrations, would bring about an agreeable surprise, because better results are obtained when a city insists upon uniform and durable sidewalks, laid according to plans and specifications approved by the city engineer or other proper authority.

Suburban and country roads, as well as pleasure-drives, are best constructed as a rule from telford, macadam, or gravel, or some combination of these. I will content myself with brief definitions of telford and macadam, leaving details to be sought in special existing treatises.

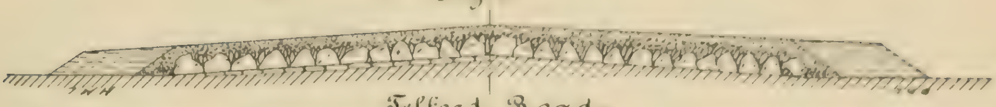


Artificial (Cement) Stone Sidewalk

A telford roadway (Fig. 11) is constructed as follows: The roadbed, being properly graded and excavated, and the proper provisions for drainage being in place, is first covered with large spalls, or kidney-shaped stones, from 6 to 8 inches deep, placed close together on end. The interstices are wedged full of smaller stones. The upper portion of the roadway is then constructed of a layer of crushed stone 3 to 4 inches deep, with another layer of finer crushed stone for a wearing surface. The whole mass is compacted by repeated rolling during construction.

A macadam roadway (Fig. 12) is constructed in the same way, ex-

Fig. 11



Telford Road

cept that the large spalls or foundation stones are omitted and the thickness of the underlying crushed stone is increased.

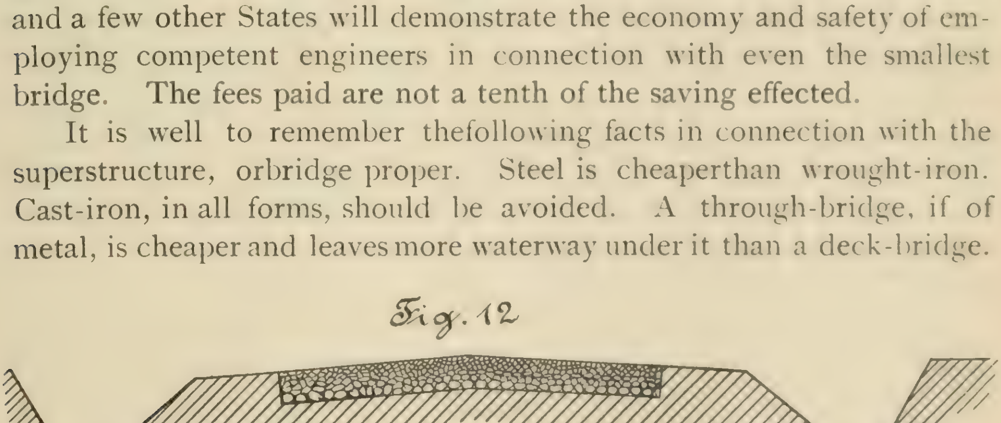
Desirable and eventually economical as macadam roads in country districts prove themselves to be, nevertheless, for some time to come in vast sections of our country, dependence must be placed upon earth roads. Our earth roads can never be made satisfactory, especially in the fall, winter, and early spring, but they could be so improved that they would sustain traffic at all seasons and keep communication open until in due time they should be replaced by gravel and macadam surfaces. The great weakness of earth roads is the lack of proper drainage. Sometimes a slight change in location is an advantage. When properly located and properly sub- and side-drained, they are fairly good in the worst seasons.

The science of bridge-building requires a knowledge of higher mathematics, strength of materials, and recorded experience. The construction of railway bridges can be undertaken only by men of special education and training. Roadway bridges (with which this article deals), whether of metal, stone, or wood, and their combinations, are cheapest and safest in the hands of engineers. They alone can obtain a maximum strength at a minimum cost.

Whereas very few railway bridges fail, because administered by scientific men, many highway bridges (an average of seven per day) fall, fail, or become dangerous in the United States. This means a loss of life, property, and business to people who can the least afford it. A tour in a carriage through parts of Massachusetts, Connecticut, and a few other States will demonstrate the economy and safety of employing competent engineers in connection with even the smallest bridge. The fees paid are not a tenth of the saving effected.

It is well to remember thefollowing facts in connection with the superstructure, orbridge proper. Steel is cheaperthan wrought-iron. Cast-iron, in all forms, should be avoided. A through-bridge, if of metal, is cheaper and leaves more waterway under it than a deck-bridge.

Fig. 12



Macadam Road

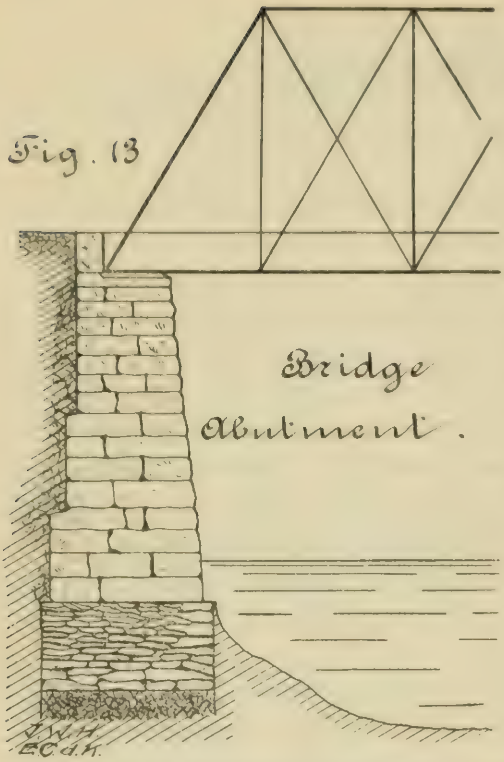


Fig. 13

All parts should be accessible for painting. Metal bridges must be kept painted, lighter colors revealing rust. Steel bridges are in the end more economical than wood, except in a few places in our country. Stone bridges, well constructed, are the most durable, and need very little attention. They are eventually the most economical.

Bridge abutments (Fig. 13) are governed in general, as to their construction, by the following rules, which at the same time demonstrate the necessity of placing competent men in charge. The soil under the foundation must be stable rock, gravel, or clay. The foundation must be deep enough to prevent scouring. The distance between abutments must be a little greater than the width of the stream at the point bridged. Foundations are best started with a layer of large, flat stones; where necessary, two layers of 4-inch planks at right angles can be used. It is wise to next introduce a strong cement concrete. The cement used throughout must be truly hydraulic, which will permanently set under water,—true of very few domestic brands. A rough rule requires the thickness at the base to be two-fifths of the height of the abutment. The slant or batter of the masonry is safe at ½ inch per foot of height. The masonry must be well bonded with headers and stretchers. The stone used is best laid on its natural bed, and of a kind which experience proves durable. Exposed joints should be less than ½ inch and firmly pointed with cement. The bridge seat on top of the abutment should extend well over the center of the wall. Wing walls must not be forgotten. Back filling of loose stone and mortar must be carefully attended to. True economy dictates the use of one part of cement and one of sand in the mortar used. The masonry should be kept free from water during erection.

Whenever a city, county, or State desires to construct a bridge, plans, specifications, and prices can best be obtained by advertising, especially in a few engineering papers. Then the employment of a competent engineer, temporarily or otherwise, will secure lasting and economic results.

ELECTRIC WIRING AND THE FIRE HAZARD.

By F. E. Cabot.

PERHAPS no element among those which enter into the causes of fire and fire-losses has caused more discussion and difference of opinion than electricity, since its introduction for light and power during the past decade. When the dynamo and its use to produce electric current first came before the commercial world, there was some distrust of this strange force, which the crude methods first employed did little to overcome. The march of progress was rapid, however, and within a short time the introduction of the incandescent lamp—"light without heat," as it was so often called—gave rise to a hope, never yet realized, that a method of illumination which could be used under all conditions and in all places had at last been discovered. Insurance officials throughout the country were delighted at the thought that the hazards of friction matches, of inflammable oils, of the contact of light-giving flame with inflammable gases and dusts in the air, were to be overcome by the use of the new light, and that no new hazard would follow in its train. In some parts of the country, insurance companies went so far as to put a premium on its introduction, by reducing rates of insurance on certain classes of factories when lit exclusively by incandescent light. But as the introduction of electricity became common and its use was extended to all parts of the country and to all sorts of buildings, rumors began to arise of fires from some cause or causes hitherto unknown, where electric wires were run, until within the last two years the pendulum has swung in the opposite direction, and not only insurance officials, but the public, are inclined to refer to electricity as the prime factor in the great increase in the fire-waste throughout the country. No sufficient proof has ever been given, or even offered, that this is the case, nor does the writer believe that up to the present time the use of electricity has been the only, or even the greatest, factor in the increase of loss by fire from which this country has suffered during the past ten years. Furthermore, there is little doubt that, with reasonable care of installation and properly-designed apparatus, electricity can be made not only a convenient but a safe method of producing light and power wherever needed, and can be used in many places where other forms of light and power are unsafe and undesirable. Yet any one who will read the quarterly reports issued by Mr. W. H. Merrill, Jr., electrician for the Chicago Fire Underwriters' Association and the Underwriters' Electrical Bureau of Chicago, will see that under *present conditions* the use of electricity for light and power adds considerably to the danger of fire. Mr. Merrill says: "Nothing approaching a complete statement of the country's fire-loss from electricity has been secured, because we have less than thirty-five electrical inspection departments in the country, and because so many fires destroy all evidences of their origin. . . . No complete statistics can be gathered from this report, and *no quotation should be given from it without the foregoing explanation.*" This summary shows that 475 fires, with a loss amounting to $1,415,610.25, were reported to him as having occurred in this country alone during the year ending October 1, 1894. This is approximately 1 per cent. of the fire-loss for the year,—a sum of sufficient importance to call attention to its causes and the means which may properly be taken to reduce it.

The writer believes that any one who cares to study the causes of fires started by electricity will be convinced that a very large proportion of these fires are from defects which would never have existed had the work of installation been done by men having a proper knowledge of the subject. He has no intention, in making this statement, of saying that the fault lies wholly or largely with the men themselves. The enormous strides which the development of this force has taken within the past ten years have made it necessary to employ, for most of the work, men whose whole knowledge of the subject has been and is most superficial. All the knowledge which workmen, or, in fact, any considerable number of persons, had on the subject was derived solely from familiarity with battery currents, and very naturally the means which had been found entirely sufficient to control these currents were still believed to be adequate. Of course, it took but a short time to show that such means would no longer suffice, and efforts were at once made to secure greater protection; There can be no reasonable doubt that, had the development of the purposes to which electricity could be applied, and of the means for producing and supplying the current adequately and economically, been, even for a time, checked in its advance, sufficient means of control would have been developed. But for each step in the advance of protection, the art advanced two; higher pressures were produced, machines capable of developing larger quantities of current were built, and the number of uses to which the current could be put were multiplied. Even within the past year there has been a decided tendency to increase the size of dynamos and the pressure at which they are intended to be operated, although no corresponding advance has been made either in insulation or in method of control.

In another way, too, the advance of electricity has increased the danger of fire. Through the use of the so-called low-potential system of lighting, the dynamo current now goes into every mercantile building and into almost every house in the larger cities throughout the country. Under ordinary conditions the current used for this kind of lighting makes itself known only through the light of the incandescent filament, for, though a certain amount of heat is developed in the lamp, it is not sufficient to attract attention. As a result, people felt that this current and the "light without heat" were perfectly harmless, and that the wires and lamps could be put anywhere with safety, so that the poorest forms of insulation were considered sufficient and the fusible cut-out was thought to be a perfect form of protection. In the same way the lack of knowledge and consideration of the danger from this source led to carelessness in construction-work, and allowed the employment of incompetent workmen without proper supervision. There can be no doubt that a very large proportion of the fires from electrical currents would never have occurred, if all the work had been first-rate. Any one who has had to do with work of this sort knows that there are to-day many electric-light plants, with none of the better forms of protection or insulation, which have run for years without a suspicion of danger from fire. In these cases careful workmanship supplied the want of better materials.

In order to understand clearly why there have been so many fires, it may be necessary to separate the ways in which they occurred, and to consider certain of these by themselves. Of the 475 fires referred to in Mr. Merrill's summary, 59 were from contact between conductors carrying electricity for light and power, and wires intended to carry only "battery" currents. These wires are, as a rule, only of sufficient size and insulation for their normal use, and, though much has been said upon the subject, are to a very considerable extent without devices providing for automatic opening of the circuit whenever a current of great pressure or quantity passes over it. Now, there can be no doubt that every one of these fifty-nine fires could have been prevented by the use of proper fuses on the battery lines where they enter buildings, and by a little more care in the construction and maintenance of such lines. The telephone companies in many parts of the country are showing how this work should be done, as they now realize how important it is that all danger of fire from this cause should be reduced to a minimum for their own protection; and in some large cities, where public sentiment against overhead wires has made itself felt, other companies having overhead "battery" lines are taking the necessary steps to protect their lines; but, in a great majority of cities in the United States where electric-light and power lines exist, much still can and should be done to lessen this danger.

One hundred and ten fires were from "grounds,"—that is, from the diversion of the current from its proper conductors to other substances making electrical connection more or less perfectly with the earth. It is fair to assume that reasonable care in the placing and maintenance of these conductors would have prevented one-half, at least, of the fires and losses from this cause. Again, nine fires resulted from the use of the *grounded* street-railway currents for commercial lighting and power, in spite of the objections urged against its use by insurance inspectors, which objections were the for most part based on the experience acquired early in the use of dynamo currents for lighting and power, and to which attention was called as early as 1882 by Mr. C. J. H. Woodbury, then in the employ of the Boston Manufacturers' Mutual Fire Insurance Company, who was, so far as the writer knows, the first person in this country to take up the hazards of electricity from the insurance point of view. He clearly pointed out at that time that one of the chief hazards then existing in the use of dynamo currents was that arising from the employment of the earth or grounded conductors for the return current. In his book, "Fire Protection of Mills," published in 1882, Mr. Woodbury says: "Each machine should be used with a complete wire circuit, and connection of wire with pipes, or the use of ground circuits in any other method, is absolutely prohibited." This rule has been published in every set of rules issued in the interests of insurance since that time. Yet the writer has been forced more than once to listen to an elaborate argument to prove that the method objected to, which, as Mr. Woodbury showed, was unsafe and therefore undesirable from the insurance point of view, was one which it was perfectly proper to use, even with the currents used on railways, which are of high voltage and much greater in quantity than anything known when the first insurance rules were issued. These nine fires can all be justly charged directly to the managers of the power-plants furnishing such current, who were willing to jeopardize life and property for the sake of the small amount of money to be derived from the sale of such current for use in mercantile or residence buildings; or, if they plead that they did not realize the danger to others, then this loss should be charged to those who supplied the machines and apparatus for generating this current. Such persons must have had ample opportunity, through insurance rules, if in no other way, to realize the danger which would surely follow, and were bound by the common laws of humanity to give this information to all purchasers of their apparatus.

There is another way in which these grounded circuits of large volume and high potential are liable to increase the fire-loss, and that is through what is often termed the "return" current passing through the earth. When the grounded trolley circuit was first used, it was thought that the earth would furnish ample capacity for the return circuit, and that no wires would be needed for this purpose. It took but a short time, however to prove the fallacy of this reasoning. Reports began to appear in the newspapers of shocks received from water pipes and gas-pipes, and of motors run by attaching a wire to different pipes or grounded conductors within the same building. These reports were at first laughed at and believed to be erroneous, but in the course of time the attention of insurance officials, officers of telephone companies, and city officials in charge of water-works, was drawn to certain strange phenomena, and accurate tests were begun. These tests at once showed that the earth under normal conditions was far from being an adequate conductor for the current necessary to operate large street railways. The West End Street-Railway Company of Boston found a drop of potential between the power-house and parts of their longer lines of considerably over 50 volts. A road in Pennsylvania, whose power-house was located directly on a river, and whose line ran near the same stream, built their line without return wires, and trusted to ground plates in the river to furnish the balance of the circuit. Yet, when the dynamos were started and an attempt was made to operate the road, it was found impossible to obtain current enough to run one car.

As this investigation was carried on, new and striking facts were noted, and it was found that the current, for which the *earth* was to provide a circuit, was passing into all metallic pipes laid in the earth near the path of the current, and was using them in its return. Currents with a pressure of 8 to 10 volts and a quantity varying from 5 to 25 amperes were shown to be passing along gas- and water-pipes within the same building. A difference of potential of from 10 to 20 volts was found between the street-car rails and hydrants on water-pipes within 20 ft. of them. A spark was seen to jump between the ends of the rails laid on a swinging drawbridge, when the draw was turned, and on measurement a current of 500 amperes at a pressure of 15 to 17 volts passed over the wire put in to connect the ends of the rails. The writer has every reason to believe that within a short time current of this nature has passed between the gas- and water-pipes in a building in Boston in sufficient quantity to melt off the soldered connection of the gas meter. Such statements may seem unreasonable, but, except in the last case, they are capable of definite proof, and have been recognized as reliable by competent engineering experts.

Now, the effect of currents of great volume and potential, wandering as it were through the earth, is certain to make itself felt, as it is already showing the beginning of its work in the destruction of metallic pipes and conductors in the earth. This destruction, though slow, is absolutely sure wherever pipes, or uninsulated underground conductors, form a part of the railway circuit; for electrolysis depends wholly on the amount of current passing out of a conductor and into another of a different conductivity. The reply will probably be made that proper bonding of rails and ample return wires in the ground will prevent any such results; but bonds often break, and connections underground are constantly weakened by corrosion and are liable to give way, and, when they are defective, the current must find another path. Moreover, there is nothing more fixed than the law that in a divided circuit the current divides in the inverse proportion of the resistances of the paths by which it goes, and, no matter how large an amount of return wire is provided, some part of the current will certainly go through the earth, and will have an injurious effect on the metallic pipes contained therein. Sooner or later this effect will show itself, in deterioration of such pipe, and, so long as the single-trolley grounded circuit is used, there is no way of escaping from it, unless an alternating current can be used. Let us hope that an efficient substitute for the present system will be found before these effects become serious.

Now, with reference to the possibilities of overcoming the dangers which arise from the use of electricity on metallic circuits, it is reasonable to believe that all which have thus far been encountered can be overcome. That this may be accomplished as speedily and as completely as possible there must be thorough coöperation on the part of all who encounter the problems brought forward by the increasing use of electricity. It seems desirable at this point to say a word as to the work which the insurance companies throughout the country are doing to solve these problems. The work which Mr. Woodbury did in this direction for the Associated Mill Mutual Insurance Companies, to which allusion was made above, roused the interest of insurance men throughout the country, and, as a result of his work, insurance organizations have endeavored to lay down rules by which the hazards introduced by the extended use of dynamo currents could be lessened, even if not entirely overcome. Their efforts have been met by the men who were engaged in the manufacture and sale of devices and apparatus for this work in very different ways. On the one hand, the insurance inspector has been received as a friend who was working for the best interests of all concerned; on the other hand, he has met opposition of the most bitter kind. No one realizes better than the writer that the first work of any man who undertakes the problem from the insurance standpoint has been, as a rule, crude. In fact, until recently, this has been almost of necessity the case, for each man has been obliged to work out each problem with little assistance and under circumstances unfavorable to mature consideration of the result. Practically no literature on the subject existed, and, until within a short time, there has been no way in which the experience gained by one inspector was, or could be, made useful to others. As a natural result, the rules in force in different parts of the country differed in many points, and were, in part at least, the result of rather hasty judgment. Within the past two years, however, and as a result of the efforts of a few earnest inspectors, this difficulty has been overcome, and means are at hand by which the reports of their work and the experience thus gained are brought together, and uniformity of practice and rules is made possible.

The insurance companies have provided suitable means for testing apparatus, conductors and devices for electrical work, and have thus afforded an opportunity,to anyone who will ask for it, of knowing something, at least, of the safety of any new material or device before it is put upon the market. It remains to be seen how far their efforts will be seconded by those interested in the other side of the problem, and to what extent engineering experts, architects, and the public at large will coöperate. If their assistance can be gained ; if manufacturers will avail themselves of this opportunity for test ; if experts called upon to choose the best forms of apparatus will use the information thus made available,—a great work will have been accomplished. The insurance interests have taken up the problem for their own benefit, but are only too glad to allow the public to profit by the knowledge thus acquired. It is in this way alone that the best results can be obtained.

The other important factor, which can only be removed by education, by a better general understanding of this great subject, is the danger arising from the employment of unskilled and incompetent workmen. When the work of placing and arranging wires, switches, motors, lamps, and the many other details of an electric-light or -power system, is done in a thorough manner by men who have been properly taught, the number of fires caused by electricity will diminish. When architects and engineers realize that a circuit for this purpose cannot be safely put into any space which chance alone provides, and that as much energy can be conveyed through a copper wire the size of a pencil as through a large steel shaft, then good workmanship and proper devices will make safety possible, and the demand for good work will drive incompetent men from the field. Much has already been done in this direction, but much remains still undone. First cost alone is too much considered, and it is only through a better general knowlledge of the subject that the desired end can be reached. Let the facts be known, even if some forms of apparatus have to go out of the market. The good of the public is, in the end, the good of those directly connected with the development of this great power, and no small or temporary delay will be a disadvantage, if through it the safety of life or property is gained.

MINE MANAGEMENT AND SUPERINTENDENCE.

By Covington Johnson.

IT is said that a capitalist once sent on a steamer from San Francisco to the Gulf of California an engineer and a stamp mill, saying to the former; "You have a mill; choose me a mine and draw for funds." This story is not credible, but such exaggerations are used occasionally to point out the follies of men. It is said that approximately 90 per cent. of merchants fail. When folly is linked to folly, as in the case of the above capitalist and engineer, the enterprise must perforce go under. The great mistakes in mining, and those most frequently made, are: first, the hurry to get up some class of reduction works before the mine is sufficiently developed; second, mistaking the class of reduction works needed; third, overcharging the mine. There has been many a ten-stamp, dividend-paying mine swamped under a forty-stamp mill. The capacity of a mill can always be enlarged, but the money expended in excess of capacity is forever lost. There is no more painful position for a superintendent to occupy than one where he is expected to keep a forty-stamp or even a twenty-stamp mill supplied from a ten-stamp mine. It is sometimes possible to do this for a few months or even a year, but at a markedly increased cost. What could have been a paying property is changed into a cause of worry, anxiety, and disgust to owners, manager, and men. It is like overloading a pack-mule; you kill your animal, and don't reach your destination. In this poor simile your mine is your pack-mule, and your destination is that desirable thing,—a dividend.

We have improved upon the Greeks and Romans in mechanics, but not in intellectual calibre. The old Latin proverb, *festina lente* (hurry slowly), or, as the Italians have it, *chi va piano va sano*, is most applicable to mining enterprises. It would be better for the capitalist who is about to invest in mines to call in the services of three men. First, the engineer, who reports on the mine; then, granting that the report is a favorable one, let him call in a mining superintendent, whose profession, whose specialty, is the management of mines that engineers have reported on. Either might be sufficient, but it is wiser to employ both. The nature of his past work has made the manager the very crystallization of conservatism. He it is who makes the autopsy. There is another safeguard to the investor in that the superintendent having to manage the mine will be cautious in his estimates of production, as he will have to prove his report by his results. If both reports are favorable, then let an average sample of the ores produced by the mine be sent to some central point, and, upon the advice of the engineer and superintendent, let these samples be divided and sent to different metallurgists. For instance, in the case of certain silver ores, we have three methods of reduction, tried, known, and valuable,—roasting and pan amalgamation, roasting and leaching, and concentration and sulphid smelting. The technical and practical experience of the engineer and superintendent, added to the good business sense of the investor, should be able to decide upon the process to be employed with a much smaller chance of error than if a less careful proceeding were employed. We may consider that we now have the mine chosen. The method of beneficiating the ore decided upon, the superintendent begins his work. He first chooses his mine foreman, whose work he directs and with whom he consults. Sometimes this foreman is taken out of the mine and made foreman. Sometimes he is one who has been foreman at other mines. He is always chosen for his experience, ability, and force of character, and frequently and deservedly becomes a superintendent. It sometimes happens that he is a man who has had a preparatory education for his work, in school. While it is not desirable to disparage a prior technical training for the position of foreman, it must be confessed that it is preferable to have a man who has risen from the ranks, so to speak. The superintendent has then the advantage of natural selection. If all the men who work in mines were to have a technical training between the ages of twelve and eighteen, then the superintendent would be able to select as foreman a man of education, and still have what has been found desirable,—a "boss" for the men whom they consider one of themselves.

When a man is taken out of a mine and made foreman, there comes upon the men a reserve, a feeling that he is above his fellows and superior, but still one of them. They cannot hoodwink or deceive him, for he has "polished the head of a drill" in times gone by as well as they. He knows all the tricks, and there are many of them. They take pride in him because he has been one of them and has risen, and respect him because of his rise. It is well that a manager whose training has been largely theoretical should have associated with him a man whose training has been purely practical.

In large works where the mine is an extensive one and the plant a large one, and where the storehouse and office work require a share of the manager's time, a mill foreman is necessary. With free ores, the mill man should be able to get a large amount of rock through the battery, and generally a battery feeder is chosen for the position; but with ores that have to be roasted, concentrated, leached, or smelted, a man of a higher grade, a man of education, is needed,—one who has made a study of metallurgy and whose experience has been in the line required. Such a man is more expensive, but in return he does better work, and the results obtained compensate for the larger salary. Managers who have not been graduated from some mining school, as well as some who have, are sometimes chary of calling a specialist to their aid. They are afraid of being supplanted. This is a great mistake. The better the subordinates, the more will the results redound to the credit of the executive head. Let such superintendents remember that executive ability is born in a man, and cannot be instilled; *poeta nascitur non fit*, or, as the French more wittily have it, *On se fait cuisinier, mais on est né rôtisseur.* It is the rarest of things to find a specialist who is a good manager. (The reverse naturally follows.) The metallurgist generally sacrifices everything else to the success of his specialty. He would not be a successful metallurgist otherwise. Concentration of thought on one thing is necessary for his success. On the contrary, the managing mind is one that superintends all things, that has the all-seeing eye, that brings many things into cohesion to the successful end of paying dividends. The manager should employ the very best staff procurable, if not from honesty, at least from policy, for the results redound to his credit, and the staff is rarely heard of.

An eminent metallurgist, who has made the reduction of gold and silver ores a life-work, not long ago wrote to the superintendent of a famous Mexican mine, stating that he had heard that their percentages of recovery were such as could be materially improved upon, and offering to make experiments at his own expense, after which, if he found that he could make an improvement, he would contract to make such changes as would be to the advantage of the company. The superintendent knew the metallurgist, knew that he had made improvements to the substantial advantage of other companies; and yet this was the answer the metallurgist received:

"If I were to bring about any improvements now, I would be blamed for not having done so before."

Possibly such a man is more fool than knave. It would take a bullion scale to determine which. At no expense to his company he could have had the experiments made, but he refused because he might lose his place and hence his salary. He evidently cared nothing for the welfare of the men who trusted him. He has been discharged.

In the writer's opinion, the western superintendent is the equal of any, and the superior of most, in that branch of his profession. The man in the region from Colorado to the Bay, from Alaska to Panama, is not tied down to any past. From whatever mining school he comes, or even when from none, he takes up his task with the determination to work and win. He has performed and seen autopsies and is conservative. Constantly among new things, he has not in his fibre the belief that the old ways are the best ways. He is not satisfied to let well enough alone. If he is getting 80 per cent., he is constantly on the alert to get 85 per cent. He has no prejudices. He works a mixed crew. He chooses the best men, regardless of their birth ; he thus avoids combinations to steal, to shirk, to strike. A mixed crew rarely coalesces. There is a decided and well-known advantage in mixed crews. He overcomes difficulties more easily. He has been where supplies are scarce and slow to come. He has a knowledge of expedients. If he has not what he needs, he makes shift of what he has. Things must be kept going. He builds his house the last thing. He sleeps in a tent under a tree, and writes his letters on a candle-box. The beautiful and the comfortable are secondary considerations, to be thought of when the mill is built, when bullion is produced. He is for the company, morning, noon, and night ; for his own comfort last. A species of professional patriotism. What is best for the company is his religion, his life. He trusts in God perhaps, but keeps his fire-hose in good condition. He rips out an oath once in a while, wears overalls, looks a bit rough, and keeps his patent leathers and his knowledge of the classics for when he "goes below," as the saying is in Nevada, when one is going to San Francisco.

A manager's tools are his men. What the hammer and anvil is to the blacksmith, the lathe to the machinist, the hammer and drill to the miner, the men are to the manager. A knowledge of men and methods is a requisite of more importance than technical knowledge. He can employ technical ability, but the "knowing how" to manage men must be his own, personal, innate attribute. An instance to the point will best explain.

The manager of a mine in the heart of the Sierra Madre Mountains, republic of Mexico, distant fifteen days' travel from San Francisco, without telegraphic communication, had a very difficult ore to treat. Not a metallurgist himself, having had no laboratory training, he was forced to depend on another. The man he had in the assay office, one by training and ability superior to the ordinary routine of assaying, was engaged on some experiments of considerable importance, which subsequently saved several thousand dollars a year to the company. His discharge would mean a delay of at least a month in getting another man, with the further delay of beginning the experiments all over again, besides a cost to the company of $150 for travelling expenses. Such were the conditions one morning when the manager, making his daily first round, entered the laboratory with his polite, suave "Good morning, X——."

The chemist, like many men who work before fires, was irritable to a degree, crotchety, and, when flaring, sometimes insulting.

"I don't want any blankety-blank, blank of blank manager come around bothering me," answered the assayer, in a flare of irritability.

"Very well, Mr. X——," returned the manager, "you'll hear from me to-morrow morning."

It was well known to the manager, as he had studied men, that those given to sudden outbursts regret them almost immediately, and suffer by anticipation from the consequences that may ensue. To be insulted by an employee and not resent it would endanger discipline. To resent it by knocking the man down, getting into a fight, and then discharging him, would have brought on the evil consequences of delay above mentioned. He heard during the day that the chemist expected to be discharged and had remarked "that he didn't have a cent, had forwarded his check to his wife, was a d—d fool anyway, and could never hold down a job."

Next morning, at his usual hour, the manager entered the laboratory, holding in his hand a letter. The trembling chemist rose to receive him He hadn't a cent, owed money, would have to borrow more to get away. The future yawned before him; he saw his dependent wife undergoing again the misery of want.

"Mr. X," said the manager, "who is the 'blankety-blank' this morning?"

"I am. My God! I am," answered X.

"Very well," said the manager, "this letter need not be sent; go on with your work." And he walked out.

The office-boy had been present at both interviews, and the story leaked out, with the result that discipline was more than maintained. By policy, or by a sense of humor, as you will, the manager retained a man who at that moment was valuable to the company.

In managing a mine accessible at all times to a base of supplies, the difficulties are very few, when the affair is in the hands of a capable man. Shoveling snow is a job to a fool. Only such mines as are hemmed in by snow for four months in the year are difficult to conduct in the United States, strikes and technical difficulties of course excepted. Strikes are frequently allowed to come to a head when the superintendent lacks diplomacy or the manager good common sense.

It is in foreign countries like the Spanish Americas, where diplomacy is most lacking, that a clash with the authorities is most dangerous. According to the writer's experience, there need not be a clash, especially in Mexico, where courtesy, politeness, and an appreciation of the Mexican's many good points, go a great way. If social methods do not remove the difficulties, then a job at a dollar a day as Velador to the Jefe Politico's wife's second cousin, or other methods equally simple, will bring about harmony and sometimes save interruptions and money. In Mexico, under the able management of that remarkable man Diaz, there is safety for life and bullion. No trains are held up ; no bullion trains are stopped ; there are no strikes ; and, with the mintage tax off, it would be a better place for mining than the United States, except in those localities where distance from a base makes supplies expensive.

While it would be well if the superintendent knew all that is to be known about metallurgy in its varied and far-reaching branches,—about geology, about mechanical as well as electrical engineering and hydraulics,—this is not possible ; the human mind is not capable of so much, and what is required of him in its stead is the ability and the knowledge requisite in order to see what are the mechanical, metallurgical, or electrical necessities of his case, and, when the difficulties are above the ordinary knowledge of a mining engineer, to know what specialist to call upon. And for this reason, and to assist the superintendent, it would be well for all companies to supply their managers with such publications as treat of the mining and reduction of ores, even remotely. The important ones can be counted on the hand. THE ENGINEERING MAGAZINE (monthly), *The Engineering and Mining Journal* (weekly), *The Scientific American* with supplement (weekly), all of New York, and *The Mining and Scientific Press* (weekly), of San Francisco. There are other foreign and domestic publications of decided value. The expense is small compared to the gain to their men, and there can be no doubt that most companies would be willing if the matter were brought to their attention, the superintendent hesitating to do so. One may ask why the superintendent does not procure such publications himself. In many cases he does. In other cases, where his pay is small and his family large, he very foolishly economizes in the direction in which he least ought to. A constant and alert attention to the improvements that are going on in the world is a duty that he owes to himself and to his company. He hesitates to put out the money, because his term of office is uncertain, or from a penny-wise policy, or for some other reason equally controvertible.

In conclusion, let the manager always bear in mind that a reduction in expenses is equal to so much more bullion produced. When he can decrease the one and increase the other, his salary should be raised.

The yearn of the superintendent is heard over the land.

CAUSES OF FLOODS IN WESTERN RIVERS.

By Charles B. Going, Ph. B.

WHEN the sun, working higher and higher toward the north from the winter solstice, brings a January thaw over the Appalachian mountains, and the spring storms, fresh from the warm Gulf and chilled to find winter still reigning in the land, gloom and sulk over the central valleys and northern hills, little rivulets of snow- and rain-water gather from a thousand ravines and mountain-slopes and hurry downward to the sea.

Their upper courses, whether they be turned east or west, are much the same. Stained with gravel, burdened with drift, the current leaps along in the recklessness of youth, here robbing a farmer of stock or fences, there making sport with a bridge or working mischief with a turnpike or railroad; but, when the brook has become a river, if it be an eastern river, its turbulent childhood seems to be subdued to the staidness of the surrounding civilization. It sweeps soberly through the cities, mindful of boundaries, respectful to property rights,—a creature of law and order.

To the larger eastern cities and towns a flood would be considerably more astonishing than an earthquake. Imagine, if you can, a water famine in Poughkeepsie occasioned by the drowning of the water-works by the Hudson; conceive of the situation in New York, if the roads entering the Grand Central Depot were landing passengers at One-hundred-and-tenth street, because there was three feet of water on the depot floors; figure to yourself the suspension of traffic between Philadelphia and Baltimore because the Delaware was out of its banks and stretching a mile or so into the bordering country. Yet on the western side of the mountains such things as these happen almost annually: in Pittsburgh and Cincinnati, in Louisville and Chattanooga, in New Orleans and the whole western river country, the spring flood is a yearly menace and a frequently-recurring disaster. Business is impeded, tracks are flooded, traffic is embarrassed, loss and destruction are suffered spring after spring, because rivers which in August and September fall so low that the steamers can no longer drag their keels over the sand-bars, in late winter are frequently so high that boats, even with their funnels lowered, cannot pass under the lofty bridges.

A state of affairs which in New York or Boston would recall the days of Noah and weaken faith in the promise of the rainbow is in Cincinnati or Louisville considered merely an unfortunate, but generally necessary, " February flood "; but even in the west, we are told, these disasters are becoming more common. The ancient steamboat-man remembers that the river used to be less wildly irregular and navigation more continuous ; the oldest inhabitant asserts that "the climate is changing."

All sorts of explanations are offered. Some attribute the entire difficulty to the Mississippi levees ; others gravely affirm that the trouble is wholly due to the erection of a few bridge-piers ; we are solemnly assured that an encroachment of a few rods on the channel by a waste-pile at a coal-yard or sawmill is responsible for the flooding of two thousand miles of valley above and below the obstruction. "Snow in the mountains" still cries lustily for recognition as the sole and only cause, though the past decade has witnessed many floods coming when there was no snow at all in the mountains, and the anomalous fact would always assert itself that snow on the eastern slope did not produce parallel results.

In truth, the phenomenon must be attributed to the conjunction of a number of causes, of which the first is topographical. Glance for a moment at a map of the United States, and notice the striking difference between the drainage systems of the eastern slope and the central basin. The former, with a total area of less than 250,000 square miles, is divided by the buttresses of the Appalachian chain into many valleys of limited area, each served by a distinct and separate drainage channel. The Hudson, the Delaware, the Susquehanna, the Potomac, the Rappahannock, the James, the Roanoke, the Santee, the Altamaha, the Savannah, and a multitude of smaller streams independently discharge the eastern rainfall into the sea, most of them through channels of abundant size,—channels which are in their lower courses practically arms of the sea, carrying up tide-water to receive the mountain streams a hundred miles or more from the ocean, and offering an enormous factor of safety in case of any unusual demand upon their capacity.

On the western side of the mountains the condition is very different. With five times as large an area to drain, the number of discharge channels is so reduced by repeated confluences during their meanderings in the alluvial plain that (with the exception of a few minor southern streams and inconsiderable outlets to the great lakes) the entire rainfall draining from the States between the mountains and the Mississippi must be carried by the Ohio river ; and the entire basin from Appalachians to Rockies, from the watershed bordering the great lakes to the northern boundary of Texas, must depend for outlet upon the Mississippi river, with a bed smaller than almost any one of the more important eastern streams. At New Orleans, for example, it has a width of 2400 feet. The drainage area above this point is about 1,200,000 square miles : the Potomac at Washington, with a width of 2380 feet, carries the drainage of a basin of only about 15,000 square miles.

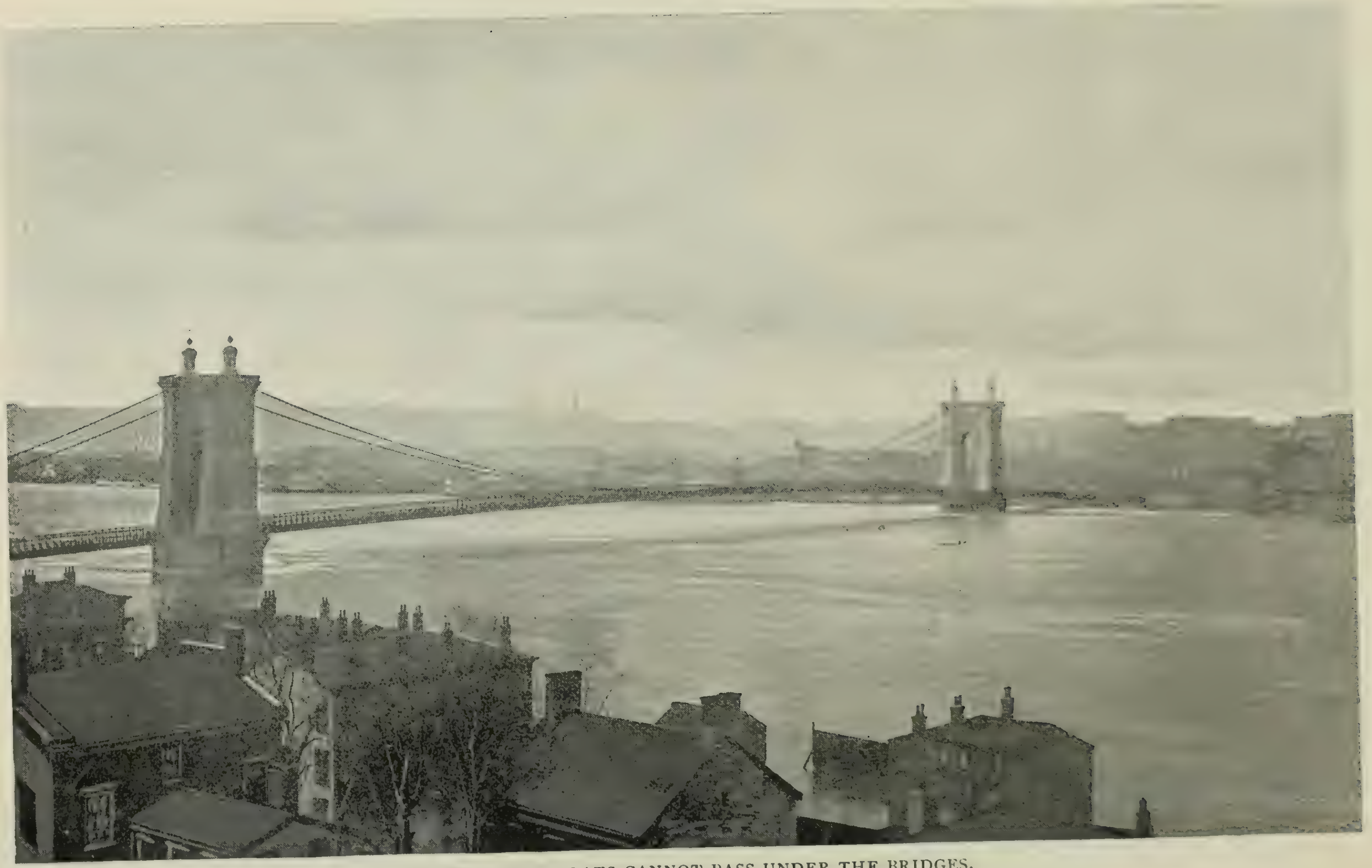
A deluge from the deep snows of the Alleghenies is so divided, on the eastern slope, between all the rivers from Pennsylvania to Georgia that the citizen of the coast-towns knows of it only as a chance newspaper paragraph ; but the merchant in the Cincinnati "bottoms" will, within a week, have that deluge gathered from a hundred creeks and delivered on his warehouse floor. A month later the dweller in New Orleans watches it fearfully as, joined to the flood from melting snows in Minnesota or the Rockies, it laps the crest of the levees.

The second main cause is geologic, and lies in the impervious character of the soils and underlying strata of the interior basin. As the mountain-ridges die away into the central plains, the folded sandstones, schists, and other porous rocks give place to flat, unfaulted limestone strata, and the clean, deep gravels are replaced by solid clays. The rains which on the whole eastern slope tarry in lakes, or find ready percolation down into subterranean pockets, whence they may filter forth gradually in a thousand springs, on the western side are almost entirely shed from the surface, and there is much less bountiful provision either of surface or underground reservoirs to absorb excessive precipitation and equalize its discharge into the rivers. The result is that a rainfall which might take weeks or months for distribution to its many channels to the Atlantic will in fewer days be sweeping in a flood-wave down its limited roadway toward the Gulf.

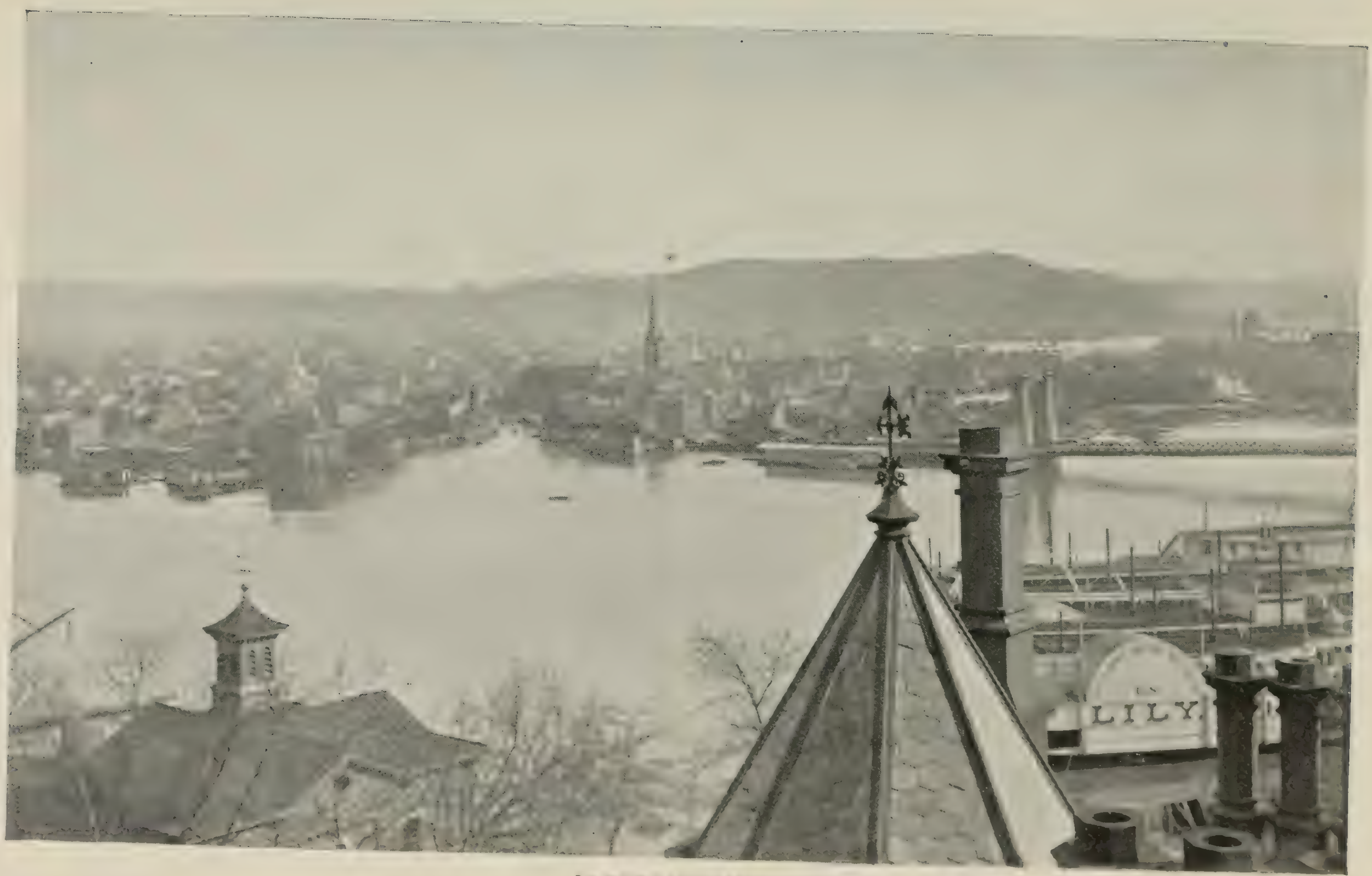
The third great cause is climatic ; for to a far greater degree westwardly than eastwardly the year is divided into a rainy and a dry season. Not so much that the total rainfall is greater, although this is true in regard to the immediate basin of the lower Mississippi and Tennessee rivers, in which fall the heavy rainstorms caused by the impinging of warm, "low" areas from the Gulf upon the cold air of the north-west.

In this region is the largest area in the United States showing a mean monthly rainfall of over six inches ; but even more important in its influence is the concentration of the precipitation in a limited portion of the year. While Atlantic coast stations, in the average, show a pretty close approximation to a uniform rainfall the whole season round, the districts of the Mississippi, Missouri, and Ohio rivers vary from barely 2 inches per month in autumn to about 5 inches in late winter : and the excessive precipitation comes just at the time when an accumulated snowfall is likely to be liberated by spring thaws. Waterways which would be adequate to an enormously increased discharge, if the flow were constant, are overtaxed for two months, and perhaps soon after dwindle into insignificance.

A CONDITION WHICH IN THE EAST WOULD RECALL THE DAYS OF NOAH.



SO HIGH THAT BOATS CANNOT PASS UNDER THE BRIDGES.



IN THE BACKWATER.

It may be that the oldest inhabitant is right in asserting that the season used to be more equable; it may be that man is partly responsible for this increased irregularity; but certainly he is wholly accountable for a remaining cause of floods, the artificial element which emphasizes and heightens all others. This is two fold,—deforestation and drainage. Not only has the lumberman's axe stripped the hillsides of the forest whose cover retarded the rapid thaws, but the farmer has felled acre after acre of timber which once afforded a deep absorbent bed of leaves and myriad tiny pockets for the retention of the rain; and, even where some wood pasture has been preserved, it has been thinned and cleared of all the undergrowth whose interlacing roots checked the rapid surface rush of the rain.

Thousands of square miles, once covered by the vast natural sponge of the forest, now spread to the sky a bare surface of hard clay, shedding water almost like the roof of a house; and every little boggy spot, every hollow where the water collected and stood through the spring, has been ditched and drained in the frantic effort to gain a few more rods for the growing of wheat. Miles upon miles of tiling underlie the land; ditches rival canals in extent and magnitude, rushing the rainfall into the streams, getting rid of water as if it were a curse,—and this in a country where almost every summer the wells run dry, and for weeks the farmer hauls water for his house and his

LOW WATER.

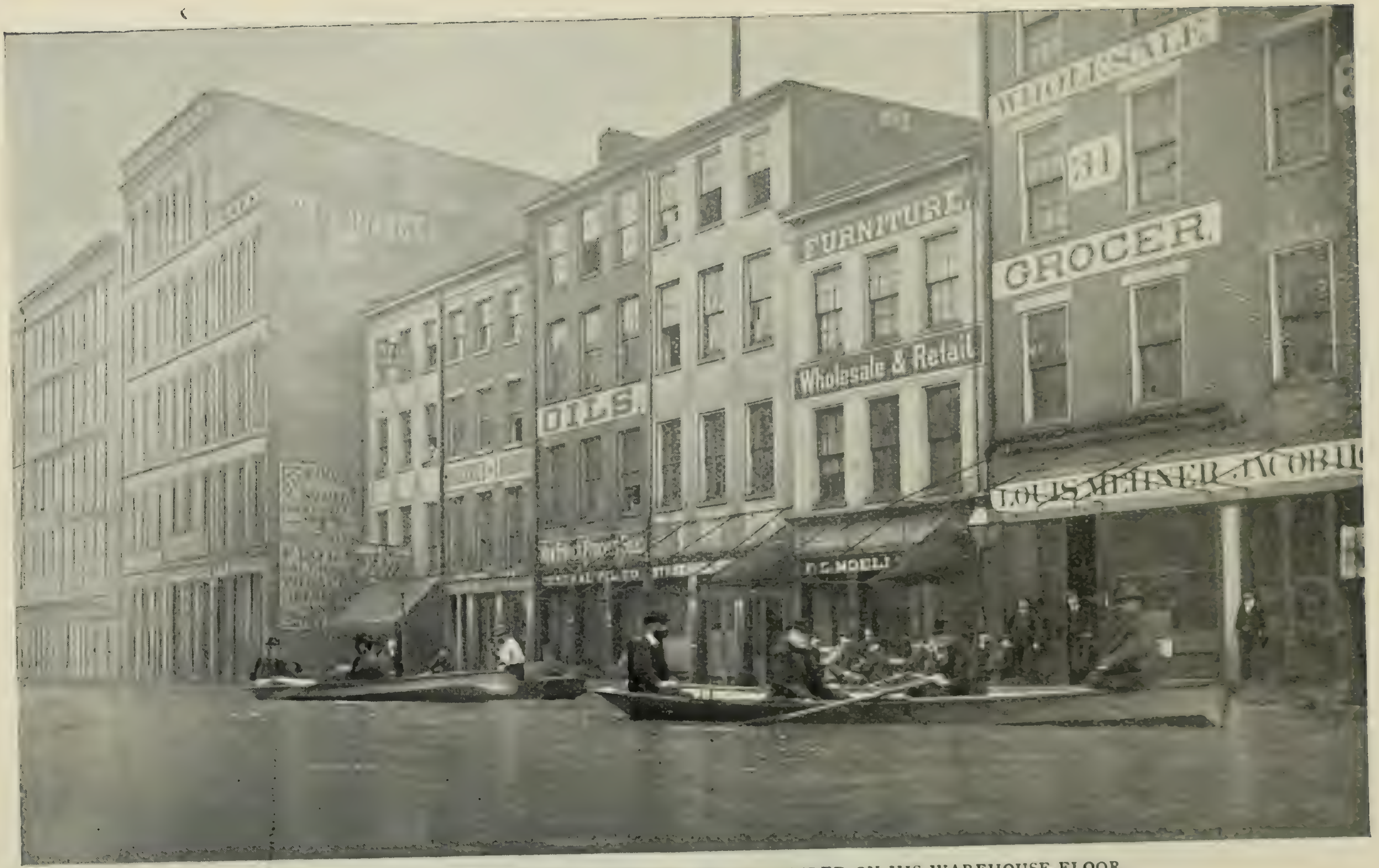
MEDIUM LOW WATER.

stock, while his corn burns in the field and he cries to heaven to break the drouth.

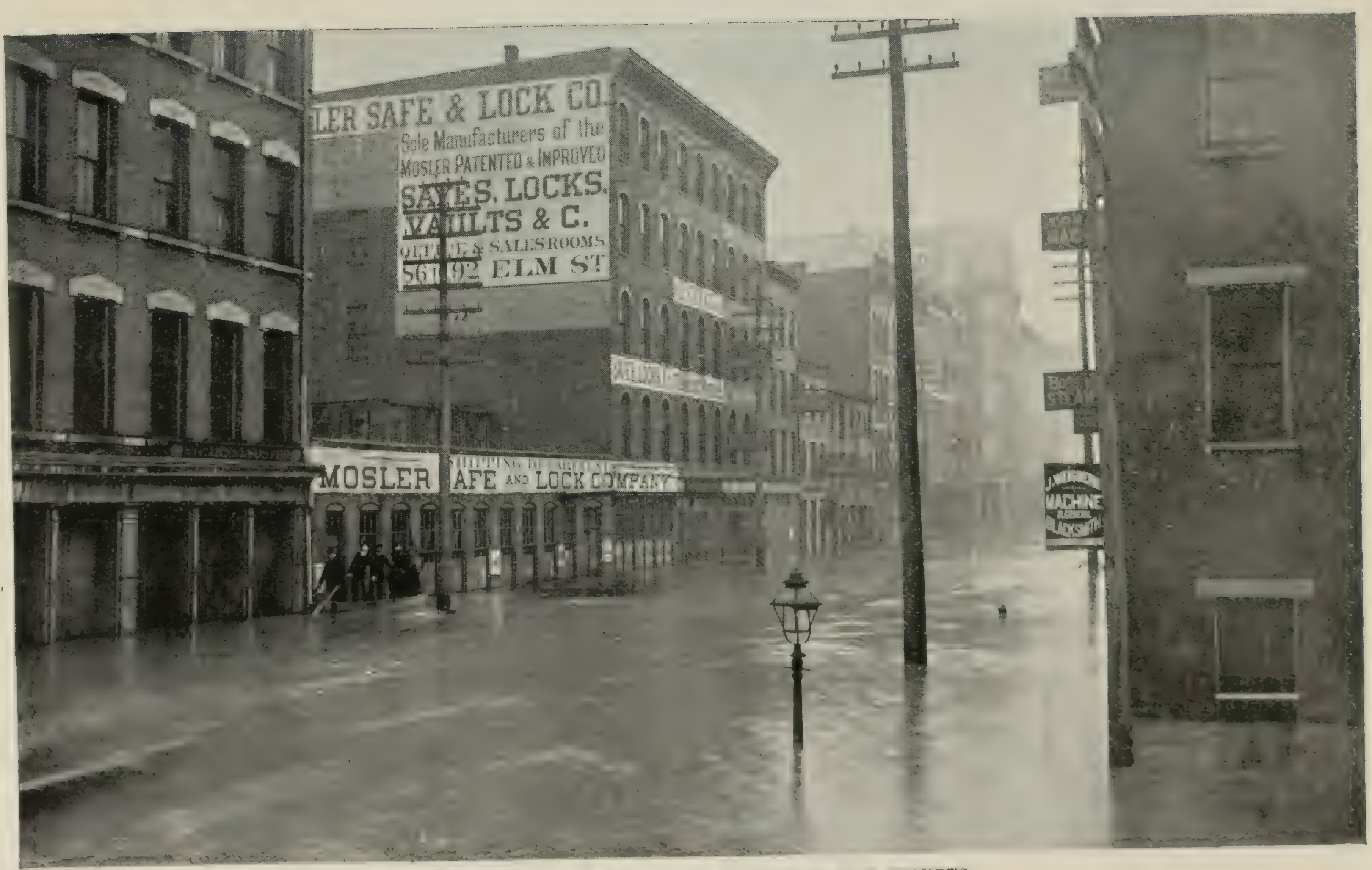
From the great tracts of recently reclaimed "marsh" which, almost bordering upon the great lakes, yet are drained into the headwaters of Ohio tributaries, down to little swales and ponds pocketed in the southern hills,—everywhere, with axe, ditch, and under-drain, the dweller in the land has been feverishly busy exaggerating topographical dangers, quickening the soil's too great tendency to shed the rains, heightening the evil effects of the seasons' inequalities, until, in a region where the annual rain-fall is over 40 inches, an adequate water-supply the year around is hard to obtain; and a city which sees the river rioting through its streets in early spring cannot find in the same stream a sufficient volume of flow to secure a supply of wholesome water for its citizens in the late summer.

The components in the problem, then, appear to be four: peculiarities of topography, difficulties of geological formation, defects of climate, and delinquencies of man.

Diagnosis, however, is only useful as it affords suggestions for relief. The crying need is not for an answer to the question: "Why do floods occur?" but to the more practical one: "How can floods



THE CINCINNATI MERCHANT HAS THE FLOOD DELIVERED ON HIS WAREHOUSE FLOOR.



FEBRUARY FINDS THE RIVER RIOTING IN THE STREETS.

RAILROAD TRACKS ARE FLOODED.

be prevented?" and we may at once answer: "*Not* by control of the main streams." It would be as easy to control an exploding boiler or extinguish the forest fire which is sweeping half a State. But the management of the tributaries would be an affair of much less difficulty, and perhaps a feasible undertaking. Their extreme rise, even in the more important and navigable lower reaches, rarely equals 20 feet; their flood planes are limited and, on account of the frequency of their overflow, not extremely valuable.

It would not seem impossible to devise a system of dams and locks by which the greater portion of the freshet in the minor rivers could be retained in great semi-natural reservoirs, and an important double purpose thereby be served: first, the avoidance of the successive discharges of tributary flood-waves upon the very crest of the flood-wave in the main channel,—the condition by which disastrous freshets in the great cities are now generally occasioned; second, by the gradual liberation of the stored waters, the maintenance of a navigable stage in the principal stream for a much longer season than the present average.

The scheme seems a daring one, but is most strongly advocated by Mr. C. Ellet, Jr., in his work on the Ohio and Mississippi rivers. He finds no important engineering difficulties to be overcome, and considers cost unimportant in comparison with the enormous resultant saving and gain.

In considering the suggestion, it must be remembered that it is not the entire freshet which must be penned up, but only that portion of it which causes the last disastrous rise. In the Ohio at Cincinnati, for instance, a rise of fifty feet does comparatively little damage ; it is the additional ten feet, raising this stage to sixty, that change an inconvenience into a calamity.

But perhaps the most really feasible amelioration is to be found by going still further back,—to conditions affecting the watershed itself. Reforestation, such as that suggested by Mr. Gifford in his admirable paper on "Forest Fires," in THE ENGINEERING MAGAZINE for November, 1894, would exert a marked beneficial influence ; for, apart from the much debated effect on climate, every little forest patch would be a natural reservoir, retaining the water in its deep mould, retarding with its roots the rapid surface wash, and to some extent checking by its shelter the unduly rapid thaw of the snow. And, in the replanted timber and that now standing, let the natural undergrowth come up again ; for, apart from any consideration of preservation of flora and fauna (aspects which the practical farmer might

TRAFFIC IS IMPEDED.

AN ANNUAL INCIDENT OF THE COAL BUSINESS.

HAVOC IN THE LUMBER YARDS.

consider foolish sentiment), its destruction, as Mr. Gifford ably shows, is bad husbandry, worse forestry, and worst of all for conservation of water-supply.

But perhaps most is to be expected from a readjustment of the artificial drainage system. If the farmers, warned by repeated burning drouths of past years, would but recognize that water is a commodity of inestimable value and least procurable when most needed, but to be had for the gathering if sought in time,—nay, that it hardly needs to be gathered, but will collect itself, if the most simple means be provided; if, instead of hurrying the precious spring rain off the land, every man or each small company of neighbors would store some of it, at least, *on* the land,—they would become wise conservators, not only of their own best interests, but also of the property and safety of dwellers along the streams hundreds of miles below them.

There need be no interference with the reclamation of swamp grounds; but the water should, wherever possible, be gathered into small reservoirs, instead of discharged directly into the nearest stream. The expense would generally be less than that required under the present plan; the sacrifice of land would be trifling—perhaps no greater than that now required for ditches; but in any event, with wheat bringing less than 50 cents and three crops in his barn, the agriculturist of the central States might perhaps afford to spare an acre or two of his wheat land, especially if by so doing he could protect the

THE BUSINESS OUTLOOK RATHER CHEERLESS.

rest. For, in many cases, with but small expense, a simple irrigation system could be devised in connection with the small reservoir scheme, and many a precious crop, which now burns in the ground, could be saved through the conservation and application of the rainfall to its natural use,—the refreshing of the earth throughout the year.

The possession of a small pond on the farm could also add materially to the comfort and the income of the owner. It might provide a supply of ice sufficient,—not only for his own use, but for sale.* It would water his stock the year around, to the saving of his time, his muscles, and his well. He might add ducks and geese to his barn-yard fowl, or, without expense, indulge in the luxury and incidental profit of a private fish-pond; and his kitchen- or market-garden, if he have one, would be saved from the destruction which now so often overtakes it when the well runs dry and it is barely possible, even with long hauling, to procure enough water for the stock and for domestic use.

In these multiple small reservoirs, it seems to me, lies the greatest and speediest hope. The plan has not the scope of Mr. Ellet's stream-control, in that it offers no possibility of subsequent maintenance of a navigable stage in the rivers; but it would perhaps deal quite as efficiently with that sudden overwhelming excess of precipitation which furnishes the highest and most destructive element of the flood.

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* A foot of ice on a pond 1 acre in extent is about 1100 tons.

It would, at all events, work most harmoniously with Mr. Ellet's plan in checking the highest winter freshets, and it would in no way diminish the summer volume of the rivers, which is derived from deep drainage and not from surface flow. The beauty of the arrangement is that it would directly and munificently reward those who put it into effect, and that each particular enterprise would call only for individual decision and would come within the reach of private means, while the larger system of control would be almost or altogether a national undertaking, requiring a public appropriation and no doubt arousing a powerful organized opposition. It may and probably will come—"some day"; reforestation and readjustment of drainage can begin *to-day.*

Geologic formation cannot be changed; climatic conditions are to be altered slowly and slightly, if at all; but the effects of topography can be enormously modified by a conjunction of minute changes, and the defaults and errors of man's work can be corrected, until such a paper as this shall be no longer possible, because there will no longer be any "Floods in Western Rivers."

THE GAS WORKS FLOODED.

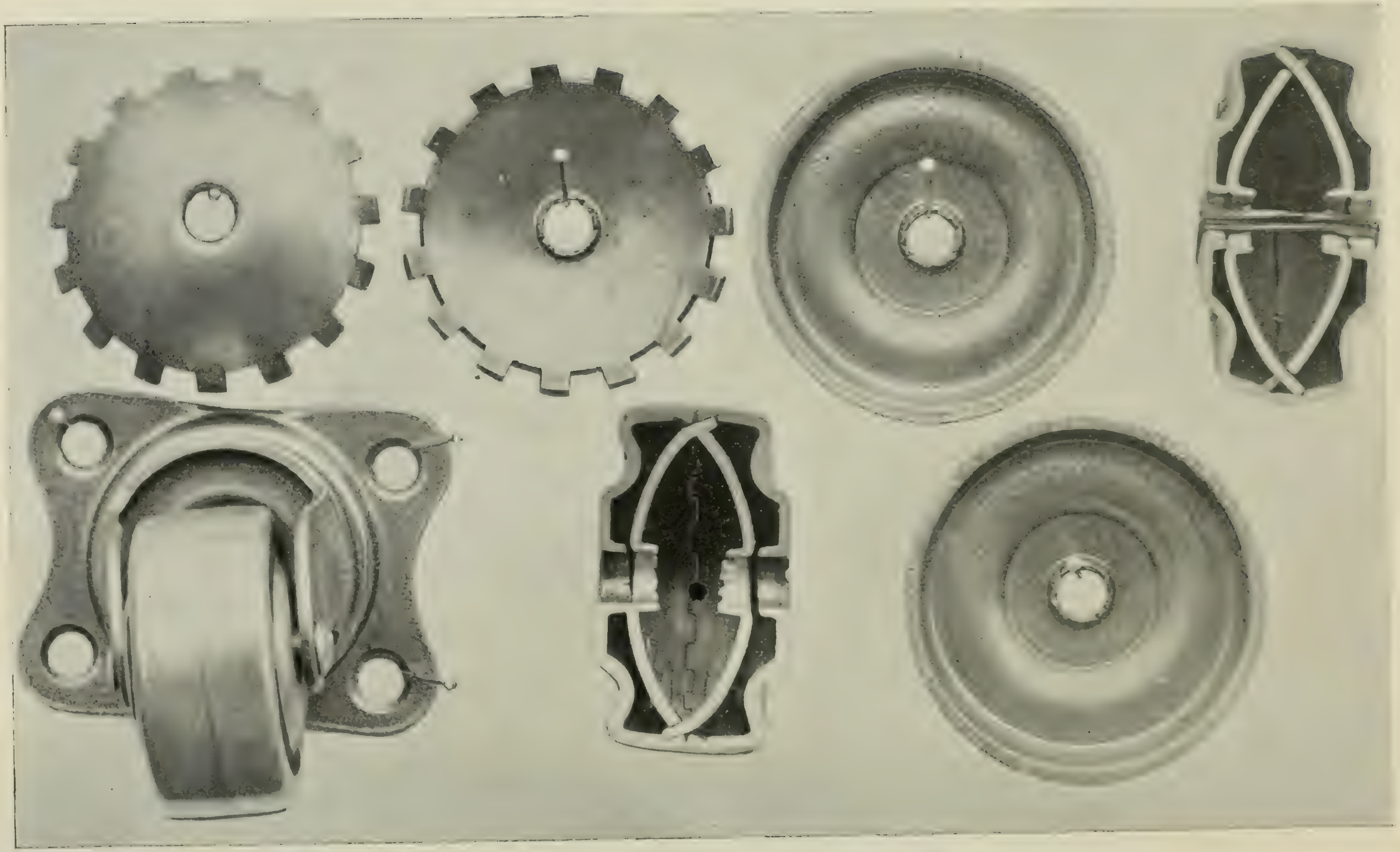

PLATE I.

THE CONQUEST OF STEEL OVER CAST IRON.

By Horace L. Arnold.

THE constant improvements in steel manufacture, and our vast natural resources in the way of ore and coal, coupled with the eager competition of steel makers in search of a market for their product, have brought the price of wrought steel in the form of superbly-finished round bars and plates to such a point as to give the manufacturer of small metal wares a new constructive material.

Until within a very few years the manufacturer who wished to increase strength and decrease weight in the very large line of manufactures sold to builders, house finishers, and housekeepers by the substitution of wrought metal for grey iron was confronted at the outset by an almost prohibitive increase in the cost of structural material.

So great was the difference in price between what was known as "Norway" iron in the sheet and small castings that the manufacturer, although well aware of the advantages in many cases to be gained by commencing his operations with metal in the sheet rather than melted

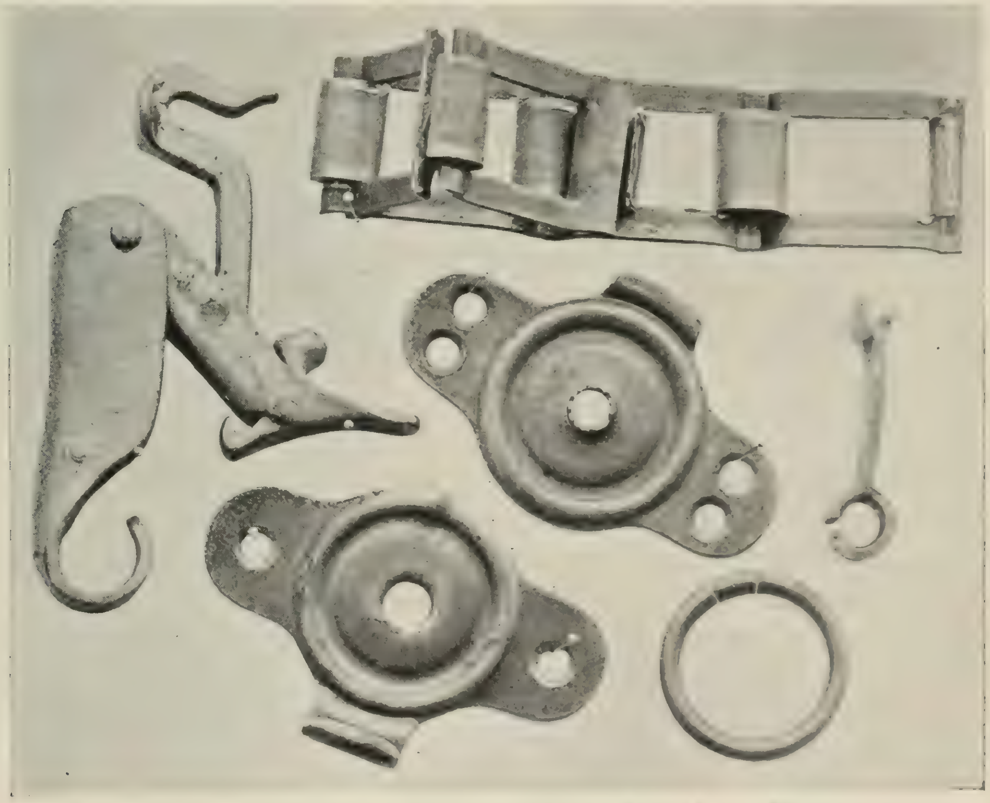

PLATE II.

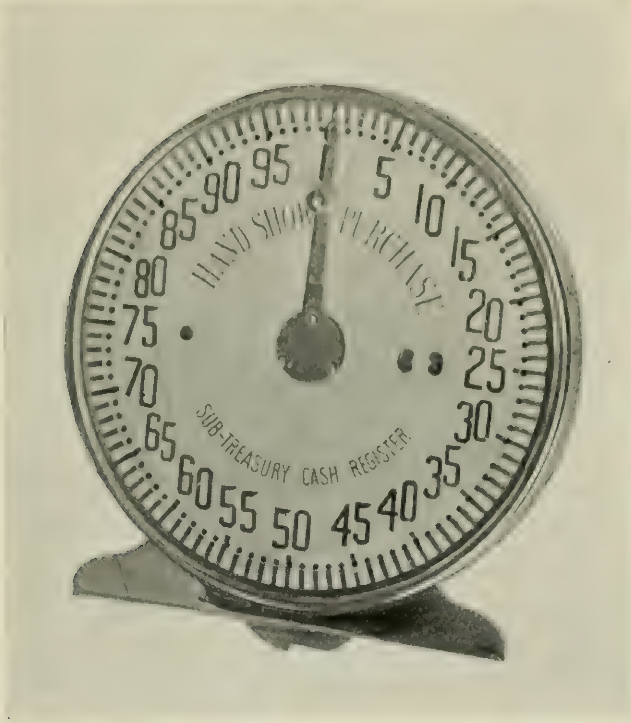

PLATE III.

iron in the founder's ladle, and by continuing with the punching press, drop hammer, and tumbling barrel rather than the moulder's flask, the pickle tub, and finishing tools constantly destroyed by the hard edges of small castings, was forced, if he wished a better result than could be obtained from rough parts, to unduly reduce the weight of the sheet-metal production to meet the selling price of the grey-iron article. Stripped and pickled "Norway" plate could be had at from 9 to 12 cents per pound in lots of from 500 lbs. to a ton; and "gun rods" from, say, 4½ to 6 cents. But, with wrought-metal at these prices, grey iron was the cheaper material. Now bright steel strips rolled inside a five-hundredth limit can be bought for 2¼ cents, and a rod drawn to within a thousandth limit at a correspondingly low rate. These materials are even better than the old "Norway" and "Juniata" irons, and can be cut, formed, and cold forged into the most fantastic distortions without loss of strength. This new material, made a new factor of economical production by its low cost, is steadily displacing foundry work in small manufactures, as steel beams have already almost entirely displaced cast-iron columns in building structures.

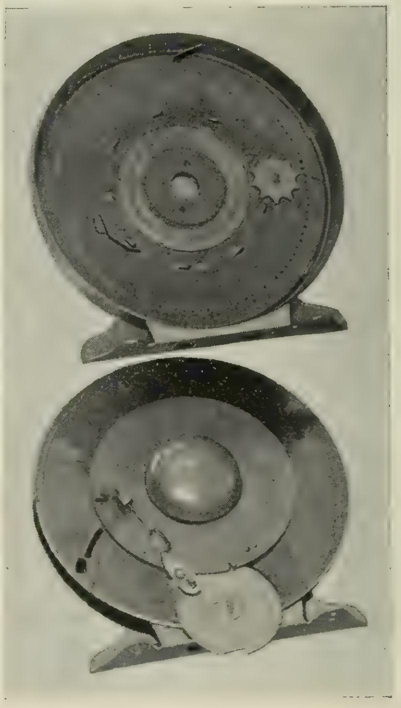

PLATE IV.

There can be no question as to the superiority of our small grey-iron castings. We have perfected the art until the every-day output of some of our foundries has as fine a skin and is as perfect in minute details of outline and ornament as the German cast-iron jewelry so long celebrated as the finest example of the moulder's product. At the North Cromwell foundry, for instance, between Hartford and Middletown on the Connecticut river, the work reaches such a close approximation to perfection in the points of uniformity of size, smoothness of surface, perfection of outline to the entire exclusion of fins and sprue marks, and uniform texture of metal, as to fill every requirement in the way of assembling and finishing the extremely ingenious and often quite complicated toys which are the principal product of that picturesque and peaceful hamlet, the name and existence of which are hardly known outside of the dealers in its wares. Not only do we produce grey-iron castings which are fine and perfect, but we make them at an extremely low price. The North Cromwell foundry ships such wheels as are put under the familiar tin toys to the German and French toy-makers. These wheels are marvels of delicate casting, from a hundred to a hundred and fifty wheels to the pound according to the size, with a hole drilled accurately in the centre of each wheel. These were sold in the times of our highest prices at 11 cents a pound. All of this work is hand-moulded, and one boy will put up a hundred or a hundred and twenty snap flasks for a day's work, each containing twelve mop-head parts with a large core in every piece, at a wage of 75 cents or $1.00 for the moulding of the entire twelve or fourteen hundred pieces. With such a low labor cost and such perfection of product, it is not a matter of surprise that manufacturers of small articles should naturally turn to castings as the cheapest and best material for the basis of their product.

In the important class of locks and hinges our grey iron castings revolutionized the methods of manufacture, and overcame the prejudices in the minds of users against the fragile material, grey iron, as compared with the wrought-metal structures previously in exclusive use. We are yet the producers of enormous quantities of cast-iron door-locks, the factories at New Britain, New Haven, and South Norwalk employing thousands of hands in fine factories in the production of really excellent locks, in which, curiously enough, the English and German lockmakers' choice of materials is exactly reversed; they made the lock-case and bolts of wrought metal, and used a cast-metal key, while we cast the case and bolts, and in a very large class of work even the lock-tumblers as well, but use a wrought-metal key, a flat steel key, which we first inserted in a cut in a barrel forming part of the lock to make it turn smoothly and easily, but later built up around the bit to secure a good turning action.

We made grey-iron castings much stronger, weight for weight, than had ever before been commercially known. To such perfection was the art of mixing and melting iron brought that our small grey-iron castings would bend a long way before breaking, and at the same time have great stiffness and elasticity ; so that we really make good durable work with our cast-iron substitute for wrought metal, which was, until quite recently, the final resort where the lowest cost of production must be had.

We have now, however, reached a market price for sheet steel, cut in strips to suit the purchaser's needs and rolled very accurately to thickness, which threatens the supremacy of grey iron as the chief factor in low-cost production of small manufactures. The utmost efforts of the foundryman fail to bring the price of fine castings to 2¼ cents per pound. Indeed, it requires extreme care in every detail to bring the first cost of fine castings, such as are used in locks, casters, and house trimmings, much below 2½ cents per pound. Although patterns are made and gated with the utmost skill, and used in connection with snaps and matches of incredible convenience and perfection, so that the patterns " jump out of the sand themselves," as moulders express their easy and perfect leaving of the flask, there are still large and unavoidable expenses attending the production and use of small grey-iron castings. In spite of the best efforts of the melter, there is a considerable percentage of loss of stock in the cupola ; no matter how diligently the riddle is used, there is another small loss on the floor ; and, though the sand is so fine and the skin of the casting so perfect that the work comes almost clean when shaken out, it must all be handled over the wheel and through the tumbler. Patterns are expensive, and must be kept up ; oil matches require some attention ; and there is a far higher grade of handicraft skill required of the moulder than of the rolling-mill hand and press feeder. All of these small factors unite to prevent the reduction of the cost of small grey-iron castings much below that obtained with present methods, so that, with sheet steel at 2¼ cents per pound, and our present skill in die-making and the very great excellence of our presses, it is doubtful if any small wares can be made more cheaply in grey iron than in steel.

At first sight this proposition seems absurd. Grey iron lends itself so readily, through its fluid condition, to the acquirement of any desired shape that the mind at once turns to that material when an article of complex figure is presented for construction. A ladleful of melted iron fills the intricacies of a properly-prepared mould with no greater power requirement than is furnished by ever-present gravity, and demands no greater resistance to confine it during the forming of its contour than is afforded by the loosely-cohering sand of the mould; sheet steel, on the contrary, offers very great resistance to changes of form, and the shaping of it requires powerful machines with tools and forms of tempered steel to give and resist the effects needed to force this stubborn material into the thousand various complicated shapes demanded by small metal wares for general use.

In many cases, however, there is not much in cost of plant in favor of the casting. The patterns may cost, for the grey-iron work, as much as, or even more than, the punch and die work for the same piece in sheet steel; and, from this point of first cost of plant, the cost is all in favor of the sheet steel, because the mould for the grey-iron work must be made anew for each individual piece produced, while tens and hundreds of thousands of pieces may be produced in sheet steel from one set of dies. Again, the very cheapest labor can be used to advantage in punch and die operations, while the grey-iron moulder, even on the simplest work, must be skilled and must exercise his skill, and, while the moulder may produce in extreme cases, say, 150 "snaps" per day, each containing possibly 50 or 75 pieces, making a total of from 7000 to 10,000 pieces per day as his extreme production, the press hand may make as high as 150 operations per minute, which would give an extreme result of 90,000 pieces in a day once through the press; and, where large quantities are produced, automatic feeds are substituted for hand feeding of the presses, so that in the cutting rooms, for instance, of some of the Waterbury brass mills one man and a boy keep a large number of presses in constant operation, at an expense so small as to be hardly appreciable for each piece cut.

Nor need these press operations be simple in their results.

Hitherto mention has been made only of the press or punching machines as a factor in wrought-metal shaping, but within the last few years the header has had its blows increased from one to two or three in a cycle, and cold forging by means of light quick blows has been brought to a point of perfection which gives it unlimited powers in seemingly widely differing directions. To these may be added the riveting machines for cold work, also operating on the general plan of very light quick blows, which move steel in any direction and to any extent without hardening the metal; indeed, the effect of the cold forging seems to be to anneal the stock, so that tool steel drawn out in the cold forging machine may be tied in knots drawn up close without a sign of fracture.

With these aids at hand, and with perfect stock of any width and thickness,—or, if round, of any length and diameter,—the supremacy of grey iron for small manufactures is not only threatened, but has already, in important lines of manufactures, been attacked and overthrown.

A few examples may be instructive to those who have not considered the matter of wrought-steel uses in small manufacturing.

A caster for use under furniture is one of the articles inseparably associated in the mind of the hardware dealer with the use of cast metal as a material. The strong fork and the substantial wheel certainly seem more suitably constructed of castings than of any possible shape into which sheet-metal can be distorted ; yet that such is not the case is very clearly evident from the example in plate I, which shows a sheet steel caster and the construction of its sheet-metal wheel, made by the Standard Caster and Wheel Company under the direction of Mr. E. G. Hoffman. This caster is chosen as an illustration of the new uses of sheet steel, because a caster, from the shape of its wheel-fork and wheel, would seem a very unpromising subject for improvement by the substitution of press work for foundry work, and because of the consequent very high degree of constructive talent shown in this commercially successful change. The general appearance of the complete caster is shown in the engraving to be quite similar to a cast-iron caster with the broad-faced wheel which is essential to a good tread on soft material ; the view given does not show the ball bearing, which makes this caster swivel with an ease hitherto unapproached. The construction of the wheel is particularly ingenious ; all the parts are shown, and also a section of the wheel members assembled for closing, and a sectional view of the closed wheel. This wheel is made of four pieces ; two cups, which are placed mouth to mouth to form the outer wheel surface, are internally grooved close to the edge in their single forming operation, and the two fifteen-toothed dished inside supporting plates interlock with each other and with the grooves in the outer wheel-cups, as clearly shown in the assembled parts section. In this form the wheel is placed at the mouth of a tapering die, through which it is forced by a single stroke of the press, with the effect of reducing both the flare and the outer diameter of the cups permanently, and thus causing the teeth of the interlocking internal supporting plates to grip the internal flanges of the cups and unite them firmly, while the internal supporting plates are at the same time put under a permanent compression load, which makes them very strongly resist deflection effects caused by the face of the wheel travelling under a heavy load over resistances of limited area. Despite its small size and humble use, this Hoffman caster wheel must justly rank among the finest examples of sheet-steel construction ; it is difficult to determine whether the simplicity of its construction methods or the ideal stress conditions of the finished article should

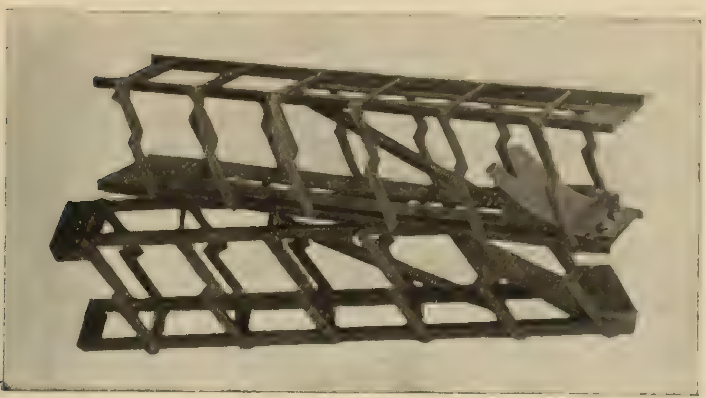

PLATE V.

most command admiration. As to the whole caster, it meets the old cast-iron article in price, while its vast superiority at all points of value has already given it an almost exclusive demand among large users.

Plate II shows articles produced in Brooklyn, N. Y. The French were the originators of the drawing press and the vast line of manufactures which depend on the use of that tool, and Mr. C. F. Vieillard appears to be endowed with the racial aptitude for manipulating sheet metals in a very marked degree. An evidence of his ability is seen in the sheet-steel drive chain which enters the automatic cutting, forming, and assembling press, in the form of a steel strip of the width of the finished chain, and comes out in the form shown at A, with its weight unchanged, but tortured into the familiar form of the open-link drive chain, at the rate of thirty or thirty-five links per minute, a speed of forty links per minute being possible. Plates III and IV show a cash-register entirely of sheet steel, a substitution throughout (except the dial hand) of sheet steel for grey iron.

Plate V shows two ladder-like frames connected by a number of side links and held in certain relative positions by a long coiled spring. Two of these structures are shown: the under one is a cast-metal structure; the upper one is the sheet-metal substitute.

B, Plate II is a hame fastener of sheet steel.

C, D, and E are the top and bottom parts of a whiffletree plate and their contained intermediate ring, a sheet steel and wire substitution for malleable iron, as in the case of the hame fastener.

Plate VI shows

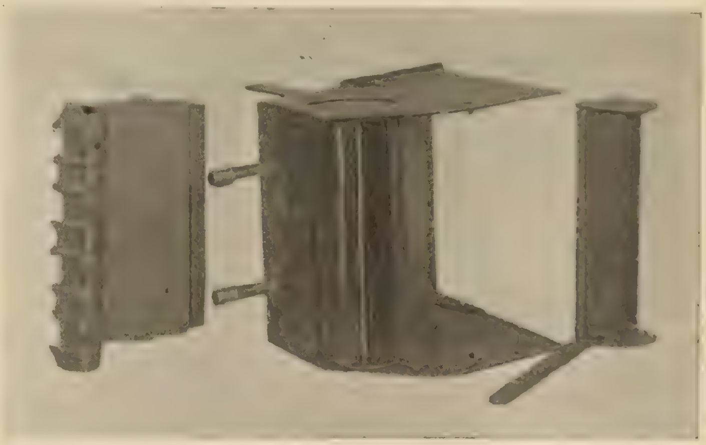

PLATE VI.

different views of the mechanism of the familiar "Stolwerck" coin-controled vending machines; these are comparatively large mechanisms, and apparently very suitably made of grey iron; the reduction in cost and the superiority of action obtained by replacing the cast iron with sheet steel were so great that the wrought-metal structure is now in exclusive use.

The caster wheel and the drive chain were selected as examples of elaborate results obtained by simple and highly instructive exhibitions of great ingenuity; the other examples may be said to be chosen at random from among thousands of articles which show that the change from grey iron to wrought steel is not confined to isolated cases. The change is organic, and cannot be otherwise than permanent. The American manufacturer who wishes to compete on the most favorable terms with the cheaper labor of other countries in the production of small articles must look to the Bessemer converter rather than to the grey-iron cupola as the womb of his work.

As to the weight-limit of the cold cut, drawn, formed, and forged piece, that is a figure which has not yet been fixed, and which may be expected to increase year by year for a long time to come. Simple forms of considerable size may be very readily made without heating the stock. The precise economical weight-limit for cold-made steel work, the exact point where heat can profitably be called in to lessen the cold metal resistances, must, it seems, depend largely upon the shape to be produced.

Of the dominant importance of wrought steel as a material in small manufactures there can be no question; and the establishment making most use of wrought steel must certainly be held, in the particular of choice of material, to have the greatest expectation of success.

ELECTRIC POWER IN SOUTHERN COTTON MILLS.

By A. F. McKissick.

THE development of the manufacture of cotton into yarns and cloth in the Southern States during the past fifteen years has been marvellous. Almost every town in the cotton-growing States has one or more cotton mills, and in many instances we find factory-towns springing up as the necessary consequence of the location of a cotton mill in an unsettled region. At first only coarse goods were manufactured, but now mills are being built for the manufacture of fine goods, in direct competition with the fine goods of the Northern mills.

The South has many advantages over the North in cotton manufacture, such as favorable climate, cheap fuel, proximity to cotton, cheap building materials, low prices for sites, water, or steam, lower rates of wages paid to a good class of help fast becoming skilful, longer hours per day, and more working days per year. The great advantages of the South for cotton manufacture have caused New England mill men to turn their eyes to the South, thus inaugurating the movement of the "mills to the cotton."

The development made in the manufacture of cotton goods in the South proves conclusively that she has the enterprise, the energy, and the engineering and mechanical skill to seize her opportunities. The South, during the past year, has increased her spindles over 250,000, the greater part of this increase being in four States,—*viz.*, the Carolinas, Georgia, and Alabama. The table on the next page, taken from the *Manufacturers' Record*, shows the growth since June, 1880, the figures for 1894 including enlargements of mills and new mills under construction,

The following table, also from the *Record*, shows the relative growth of the consumption of cotton in Northern and Southern mills since the season 1886–87 :

	Northern Mills.	Southern Mills.
1893–94	1,601,173	718,515
1892–93	1,687,766	743,348
1891–92	2,027,362	604,661
1889–90	1,799,258	546,894
1888–89	1,785,979	479,781
1887–88	1,804,993	456,090
1886–87	1,710,080	401,452

	June, 1880.			June, 1890.			Dec. 31, 1894.		
	Mills.	Spindles.	Looms.	Mills.	Spindles.	Looms	Mills.	Spindles.	Looms.
Alabama	16	49,432	863	13	79,234	1,692	30	264,458	4,019
Georgia	40	198,656	4,493	53	445,452	10,459	69	592,764	13,522
Kentucky	3	9,022	73	5	42,942	677	8	54,088	748
Maryland	19	125,706	2,425	15	158,930	2,965	22	176,786	3,520
Mississippi	8	18,568	644	9	57,004	1,352	10	62,678	1,894
North Carolina	49	92,385	1,790	91	337,786	7,254	158	743,299	14,376
South Carolina	14	82,334	1,676	34	332,784	8,546	61	730,590	20,004
Tennessee	16	35,736	818	20	97,524	2,043	27	128,066	2,539
Virginia	8	44,340	1,322	9	94,294	2,517	13	120,444	3,483
Arkansas	2	2,015	28	2	66,980	1,726	5	16,640	220
Louisiana	2	6,096	120	2			7	55,132	1,495
Florida	1	816	......	1			1	1,400	......
Texas	2	2,648	71	1			14	77,514	2,385
Total	180	667,754	14,323	255	1,712,930	39,231	425	3,023,859	68,205

Up to the beginning of 1894 the power for cotton mills was produced either from steam engines or turbines. The question as to which should be adopted depended altogether on circumstances that varied for different cases.

In a great many towns and cities in the South the question of water or steam did not come up for consideration, for the reason that there was no available water power convenient. In order that a water power may be available, it must satisfy these conditions: (1) the volume of the stream and the fall must be sufficient to guarantee the amount of power required; (2) there must be railroad facilities; (3) the stream must have a sufficient water-shed to supply the volume of water needed through the dry summer months; (4) there must be a convenient and satisfactory site for a mill that will not require excessive excavations and foundations; (5) it must be possible to build the dam at reasonable cost. With an available water power, the facts to be considered in solving the problem of steam or water are principally these: (1) cost of steam plant, and operating expenses; (2) cost of turbine plant, and operating expenses; (3) difference between cost of excavations and foundations for the mill located at the water power and at the point where steam will be used; (4) transportation expenses to railroads.

With these facts ascertained, the question, then, is which is the greater,—the operating expense of the steam plant, or the interest on the difference between cost of erection of the mill building at the water power and at the point to be selected in case steam is decided upon, plus the interest on the difference between cost of the turbine plant and that of the steam plant, plus the operating expense of the turbine plant. These are the main facts to be considered. The tendency of mill men in the South is to use water power, if possible; and there are many successful mills to-day using water power, which are located from one to three or even more miles from a railroad.

Electricity has developed to such an extent in the last few years as an agent for transmission of power that mill men have begun to realize that in some cases there are many advantages to be gained by its adoption.

The first case of adoption of electricity in the South as a means of transmission of power for a cotton mill is that of the Columbia Cotton Mills at Columbia, S. C. In this case the mere transmission of power is of trifling importance, as the distance is only a few hundred feet. The turbines in the power house are supplied with water from the recently-developed Columbia Canal, and, on account of the location of the canal at this point, it would have been utterly out of the question to use direct belt transmission from the turbines. The question, then, was whether to build the mill nearer the turbines and use rope transmission, necessitating, however, excessive excavations; or to place the mill where it is now located,—on a comparatively level site,—and use electrical transmission. The latter was decided on, and the mill started successfully in April, 1894, and has been running since that time without the slightest hitch.

This plant consists of two 750-h. p. generators direct-coupled to horizontal turbines, running at a speed of one hundred and eight revolutions per minute. This low speed was necessitated by the low head and the desire to dispense with the loss of efficiency due to belting. The line is carried in an underground conduit to the mill, and there is distributed in conduit tubing to the various floors of the mill, where are located seventeen 65-h. p. motors, suspended in an inverted position, so as to take up the minimum of space and permit of direct belting to the short sections of shafting driven by individual motors. These motors have no moving contacts of any kind, and regulate within two per cent. in the matter of speed. This plant is of great importance as exhibiting the application of electricity in the distribution of power in small units. There are no long lines of shafting in this mill, no large belts or pulleys, and each room is independent of every other.

As to the question of difference in efficiency between electrical transmission and transmission direct from turbines or steam engines by means of ropes or belts, it must be borne in mind that, when electrical transmission is used, the motor is placed where the power is needed, there are no long lines of shaftings or long belts connecting the shaftings of different floors, and, when direct transmission from turbine or steam engine is used, the whole system is made up of long lines of shafting, connected by belts extending from floor to floor, thus involving heavy friction losses. Reference is made to the following table compiled by Mr. J. J. Flather, giving the names of firms, the nature of their work, total horse-power use, horse power required to drive shafting, and the percentage of total power required to drive shafting.

Name of Firm.	Nature of Work.	Total Horse Power.	Horse power required to drive shafting	Percentage of total power required to drive shafting.
J. A. Fay & Co.	Wood-Working Machinery	100	15	.15
Union Iron Works	Engines and Mining Machinery	400	95	.23
Frontier Iron & Brass Co.	Marine Engines	25	8	.32
Baldwin Locomotive Works	Locomotives	2500	2000	.80
W. Sellers & Co. (One Dept.)	Heavy Machinery	102.45	40.89	.40
Pond Machine Co.	Machine Tools	180	75	.41
Yale & Towne Co.	Cranes and Locks	135.05	66.81	.49
Ferracute Machine Co.	Presses and Dies	35	11	.31
Bridgeport Forge Co.	Heavy Forgings	150	75	.50
Hartford Machine Screw Co.	Machine Screws	400	100	.25

It will be noticed that the power required to drive shafting for these cases varies from 15 per cent. to 80 per cent., the average being 38.6 per cent. Mr. J. T. Henthorne, in a paper read before the American Society of Mechanical Engineers, states that the friction of the shafting and engine in a print-mill should not exceed 19 per cent. of the full power. Out of 55 examples of a miscellaneous character which he has tabulated, 7 cases are below 20 per cent., 20 vary from 20 per cent. to 25 per cent., 15 from 25 per cent. to 30 per cent., 11 from 30 per cent. to 35 per cent., and 2 are above 35 per cent., while the average of the total number is 25.9 per cent. Mr. Barrus, speaking of this subject, quotes 8 cases, the data of which were obtained from tests made by himself in various New England cotton mills, in which the minimum percentage was 18 and the maximum 25.7, the average being 22. At the Columbia Mills 85 per cent. of the power produced by the turbines is delivered to the shaftings, which, as I have said, are very short, have no large belts or pulleys, and, consequently, cause very little friction loss, so that we can safely say that the efficiency of electrical transmission of power for the Columbia Cotton Mills, if not greater than, is certainly equal to the efficiency obtained by using belt or rope transmission in the average cotton mill.

The new fine goods mill that is being put up by the Pelzer Manufacturing Company of Pelzer, S. C., furnishes another example of the practical application of electric power. Mills Nos. 1 and 2 are driven by turbines, and No. 3 by a steam engine. These mills are on the Saluda river in Anderson Co., S. C., and are connected with the Columbia and Greenville Rail Road by a spur about ½ mile long. This company, desiring to add another mill, decided to make use of a waterfall about 2½ miles lower down the river that has a capacity of about 5000 h. p. It would have required heavy expense for excavations and foundations to have built the mill near enough to use either belt or rope transmission; so, after taking everything into consideration, it was decided to locate the mill near the other mills, where a good site could be found convenient to the spur from the railroad, and transmit the power necessary to operate the mill from the water power about 2⅝ miles distant. The dam which is now being built will have a capacity of 5000 h. p., and the new mill will be 505 ft. long, 128 ft. wide, and 4 stories high. Its capacity will be 50,000 spindles and 1700 looms, and only fine goods will be manufactured.

At the power station there will be three 1000-h. p. generators, connected direct to three horizontal turbines, running at a speed of 166 revolutions per minute. The engine that is running mill No. 3 will be replaced by a 400-h. p. synchronous motor. The new mill will require for its operation two 50-h. p. motors, four 75-h. p. motors, fourteen 110-h. p. motors, and one 20 h. p. motor. Twelve hundred 16-c. p. incandescent lamps will be used for lighting the new mill, requiring 120 h. p. The guaranteed efficiency of this plant from turbine shaft to motor shaft is 80 per cent. The largest belt in use in the mill will be 8 in. wide, and the largest pulley 30 in. in diameter. Every room is independent, and any one room may be operated without necessitating the running of long lines of shafting. The generators and motors are practically the same as those in the Columbia mills.

The advantages gained by using electrical transmission for this mill are as follows: (1) the location of the new mill at a good site, thereby saving heavy expense for excavations and foundations; (2) the mill will be near the spur from the railroad, thus saving the building and maintaining of a railroad about 3 miles long and the operation of the same; (3) the proximity of the company's offices, and hence greater convenience to the officers of the mill; (4) the saving of the duplication of the mill village conveniences, such as churches, schools, stores, lyceum, halls, etc.; (5) the mills, being near together, will be better managed than they would be if separated; (6) the replacing of the steam engine operating Mill No. 3 by an electric motor, thus saving the company an annual consumption of over 3000 tons of coal, or very nearly $10,000.

In this plant there will be very little difference in efficiency in consequence of the employment of electric transmission. Where the water power is abundant, as in this case, the question of a small difference in efficiency is not of much importance. The saving in the cost of building the mill where it is now located over what would have been the cost had it been built near enough to use belt or rope transmission, added to the saving of the cost of building a railroad 3 miles long and the saving of the cost of belts connecting different lines of shafting, very nearly equals the cost of the generators, motors, line, and lamps for lighting the mill, including the 400-h. p. motor for Mill No. 3.

The power transmitted by electricity for the operation of this mill is more economical than if it were generated by steam engines. Referring to a table showing the comparative cost of steam power developed in engines of different types, gotten up by Dr. Charles E. Emery of New York, we obtain the following data on compound low-speed condensing engines,—the kind that probably would have been used if steam power had been adopted. Friction loss of engine, 11 per cent.; pounds of coal per indicated horse-power per day of 11 hours (allowing for starting and stopping fires), 26. The coal assumed is a fair average, based on an evaporation of 8½ lbs. of water per pound of coal.

In order to have sufficient power to operate this mill, an allowance would have to be made for engine and shafting friction. Taking the friction loss of the engine from the table,—*viz.*, 11 per cent., —and assuming that the friction of one shafting (outside of the shafting to which the different machines are belted, thus putting the comparison on the same footing in both cases) increases this to 20 per cent., we would have to have an indicated horse power of 3000. The daily consumption of coal would then be 78,000 pounds, or 39 tons,—a yearly consumption (assuming 308 working days) of 12,012 tons. Assuming a price of $3.25 per ton delivered at the mill, this consumption would amount to $39,000. Now, if the interest on the cost of the dam, turbines, power station, generators, line, transformers, and motors, minus the cost of the steam plant, including chimneys, stacks, buildings, etc., exceeds this sum of $39,000, electrical transmission would evidently be out of the question. But, as a matter of fact, the interest on the cost of the complete turbine and electrical plant, including generators, motors, lines, etc., minus the cost of the steam plant, assuming 6 per cent. interest, would not amount to one-third of the cost of the coal consumption.

After considering every phase of the question, the conclusion must be drawn that the adoption of electrical transmission by this company was decidedly a step in the right direction.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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THE PUBLICATIONS REGULARLY REVIEWED.

A	**Arena.** *m.* $5. Boston.
AA	**American Architect.** *w.* $6. Boston.
An A A	**Annals of Am. Academy of Political and Social Science.** *b-m.* $6. Philadelphia.
A An	**American Analyst.** *f.* $1. New York.
A & B	**Architecture and Building.** *w.* $6. N. Y.
A B D	**Arch. Build. and Dec.** *m.* $2. Minneapolis.
A CJ	**Am. Chem. Journal.** *b-m.* $4. Baltimore.
A E C U	**Asso of Eng. of Cornell Univ.** 1894. Ithaca.
A E R J	**Am. Eng. and Railroad Journal.** *m.* $3. N. Y.
A G	**Am. Geologist.** *m.* $3.50. Minneapolis.
A G L J	**Am. Gas Light Journal.** *w.* $3. New York.
A J R A	**Jour. R'y. Appliances.** *m.* $2. New York.
A J S	**Am. Jour. of Science.** *m.* $6. New Haven.
A L	**The Architect.** *w.* 26s. London.
A M	**American Machinist.** *w.* $3. New York.
A M C	**Amer. Mag. of Civics.** *m.* $3. New York.
Am M	**American Miller.** *m.* $2. Chicago.
A M & I W	**Am. Man. and Iron World.** $4. Pittsburg.
A M S	**Aust. Mining Standard.** *w.* 30s. Sydney.
A R	**Architectural Record.** *q.* $1. New York.
A Rev	**Architectural Review.** *8-q.* $5. Boston.
A S	**Age of Steel.** *w.* $3. St. Louis.
A S I E	**An. of Amer. Soc. of Irri. Eng.** 1892-93.
A S M E	**Am. Soc. of Mec. Eng.** *m.* New York.
B	**The Builder.** *w.* 26s. London.
B A	**The British Architect.** *w.* 23s. 8*d.* London.
B B	**Brick Builder.** *m.* $2.50. Boston.
B G S	**Bul. Am. Geog. Soc.** *q.* $5. N. Y.
B I S	**Bul. Am. Iron and St. Asso.** *w.* $4. Phila.
B J C	**Boston Jour. of Commerce.** *w.* $3. Boston.
B M	**Banker's Mag.** *m.* 18s. London.
B M A	**Bankers Mag. of Australia.** *m.* $3. Melbourne.
B T J	**Board of Trade Journal.** *m.* 6s. London.
B U W	**Bul. of the Univ. of Wisconsin.**
C A	**Calif. Architect.** *m.* $3. San Francisco.
Can A	**Canadian Architect.** *m.* $2. Toronto.
C & B	**Carpentry and Building.** *m.* $1. New York.
C E	**Colliery Engineer.** *m.* $2. Scranton, Pa.
C Eng	**Canadian Engineer.** *m.* $1. Montreal.
C G	**Colliery Guardian.** *w.* 27s. 6*d.* London.
Ch	**Chautauquan.** *m.* $2. Meadville, Pa.
C M	**Century Magazine.** *m.* $4. New York.
C M R	**Canadian Mining Rev.** *m.* $1.50. Ottawa.
Com	**Commerce.** *w.* 36s. London.
Cos	**Cosmopolitan.** *m.* $1.50. New York.
C R	**Contemporary Review.** *m.* $4.50. London.
C T J	**Chem. Trade Jour.** *w.* 12s. 6*d.* Manchester.
D E	**Domestic Engineering.** *m.* $2. Chicago.
E	**Engineering.** *w.* 36s. London.
E A	**Electrical Age.** *w.* $3. New York.

E A S ...Eng. Asso of the South. *m.* $3. Nashville.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E L....Electrical Engineer. *w.* 19s. 6*d.* London.
E E N Y..Electrical Engineer. *w.* $3. New York.
E G ....Engineers' Gazette. *m.* 8s. London.
E I.......Electrical Industries. *m.* $1. Chicago.
E L.......Electricity. *w.* 7s. 6*d.* London.
El .....Electrician. *w.* 24s. London.
E M .....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N......Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36s. London.
E N Y....Electricity. *w.* $2.50. New York.
E P......Electrical Plant. *m.* 6s. London.
E R......Engineering Record. *w.* $5. New York.
E Rev....Engineering Review. *m.* 7s. London.
E R L.....Electrical Review. *w.* 21s. 8*d.* London.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W......Electrical World. *w.* $3. New York.
F ... Forum. *m.* $3. New York.
F D......The Foundry. *m.* $1. Detroit.
F R......Fortnightly Review. *m.* $4.50. London.
F W......Fire and Water. *w.* $3. New York.
F'y......Fairplay. *w.* 32s. 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6s. 6*d.* Birmingham.
G & F....Garden and Forest. *w.* $4. New York.
G M.....The Geol. Mag. *m.* 18s. London.
G R......Good Roads. *m.* $1. New York.
G W......Gas World. *w.* 13s. London.
H & V...Heating and Ventilation. *m.* $1. N. Y.
I A......Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I E.......Indian Engineering. *w.* 18 Rs. Calcutta.
I Eng....Indian Engineer. *w.* 20 Rs. Calcutta.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25s. Lond
I C B.....Carpenter and Builder. *w.* 8s. 8*d.* London.
I C T......Iron and Coal Trades. *w.* 30s. 4*d.* London.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv......Invention. *w.* 11s. London.
Ir Age..Iron Age. *w.* $4.50. New York.
I R W...India Rubber World. *m.* $3. New York.
Iry.......Ironmongery. *w.* 3s. London.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L....Journal of Gas Lighting. *w.* London.
J M W A.Jour. of United Metal Workers of America. *w.* $1. N. Y.
J N E W.Jour. N.E. Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J S A....Journal of the So. of Arts. *w.* London.
L A......The Landscape Architect. *m.* $1.50. Rochester.
L E......Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
M........Machinery. *m.* 9s. London.
M A.....Machinery. *m.* 50 cts. N. Y.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M E......Marine Engineer. *m.* 7s. 6*d.* London.
Met W...Metal Worker. *w.* $2. N. Y.
Mill......Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T ...Mining Industry. *w.* $3. Denver.
Min W..The Mining World. *w.* 21s. London.
M J. ....The Mining Jour. *w.* £1. 8s. London.
Mo ...The Monist. *qr.* $2. Chicago.
M R .....Manufacturer's Record. *w.* $4. Baltimore.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M W.....Mechanical World. *w.* 8s. 8*d.* London.
N....... Nature. *w.* $7. London.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C......Nineteenth Century. *m.* $4.50. London.
N C B...National Car Builder. *m.* $2. New York.
N S R....The New Science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
P.........Paving. & Mun. Eng. *m.* $2. Indianapolis.
P A......Progressive Age. *s-m.* $3. New York.
P E C P.Procd. Engineer's Club. *q.* $2. Phila.
P Eng...Practical Engineer. *w.* 10s. London.
Pl D .....Plumber and Decor. *m.* 6s. 6*d.* London.
Pr.......Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A ....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7s. London.
R R......Railway Review. *w.* $4. Chicago.
R W .....Railway World. *m.* 5s. London.
Ry T.. ..The Railway Times. £1. 5s. London.
S .. ..Stone. *m.* $2. Chicago.
S A .....Southern Architect. *m.* $2. Atlanta.
San......Sanitarian. *m.* $4. Brooklyn.
Sc.... ...Science. *w.* $5. Lancaster, Pa.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S ...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col.
S E......Stationary Engineer. *m.* $1. Chicago.
S Ec ....Social Economist. *m.* $1.50. N. Y.
Sea......Seaboard. *w.* $2. New York.
S In......Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L......Steamship. *m* Leith, Scotland.
S M.....ScientificMachinist. *s-m.* $1.50. Cleveland, O.
S M Q....School of Mines Quarterly. $2. N. Y.
S R .....Sanitary Record. *m.* 10s. London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P......Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V......Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E .. Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q......Technology Quarterly. $3. Boston.
Tr... ..Transport. *w.* £1. 5s. London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A...Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E......Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

London Stables.

THE proper housing of horses has received much attention from the architect's standpoint, and, as a result, these useful animals are now provided with comfortable and, in many cases, what may be styled even luxurious quarters. The subject covers many lines of construction, from compact, neat, and ornamental stables for private owners of valuable stock to livery stables, hotel stables, and the great street-car stables. Probably the cities of the United States can furnish as choice specimens of stable architecture as the world can supply; nevertheless, it is not uninteresting to read what *The Illustrated Carpenter and Builder* (Jan. 11) has to say about London stables.

First, as to the number of horses belonging to the working class, not including private carriage and riding horses; there are eighty thousand horses " working for their living in the streets of London. Of these, twenty thousand are omnibus horses, ten thousand are car horses, fifteen thousand are cab horses, and twenty-seven thousand are employed in the carrying trade. A ruling consideration in the construction of stables for London horses is the great value of the land on which they have to be erected. This was not so much so in the past, however, when many places were suburbs which are now amongst the most important parts of London; and therefore we find that most of the old-fashioned stables—those, for instance, belonging to old-established firms of carriers or brewers—are built in a very straggling manner and cover a large area of ground. Not so the stables of recent erection, which, as a rule, have been built in the most compact form possible. Thus, in a new block built by the Great Western Railroad close to its terminus at Paddington, there are no less than four floors of stables, one above the other, the top floor being almost as high as the adjacent hotel, with a look-out down on the station roof. The headquarters of Messrs Carter, Patterson & Co., the well-known London carriers, are in three floors, one over the other, and the London Road Car Company's depot at Fulham, which accommodates seven hundred horses and is considered the finest in Britain, consists of stables in two stories built around a quadrangle. For the handling and management of a large stud of horses, stables built in such compact forms as these present some advantages over old-fashioned straggling buildings, as they can readily be divided into sections, and thus the work of each horse-keeper can be clearly defined. Moreover, for light and ventilation, animals placed on the upper floors of a London building will generally be better off than those whose habitations are on a level with the ground. When the housing of working horses on a large scale in the heart of London first became common, these considerations were little regarded, and horses were often, for the sake of economy, stabled in the basements of buildings used for other purposes. Thus a portion of the large stud employed by the North Western Railroad are housed beneath the railway station at Broad street. The newest stables built by the company, however, stand on their own ground, and are lofty, bright, and airy. The greatest objection to stables built on several floors is the labor entailed in taking in supplies of food and bedding, and in removing manure, &c. In most large buildings of this type, however, hydraulic machinery is provided for these purposes."

One of the finest examples of London stable buildings is said to be that recently erected by the Great Northern Railroad close to its station at Farringdon Street, in the heart of the city. It accommodates two hundred cart-horses. The two upper floors only of this building are devoted to stables, the basement having been utilized for a warehouse, while on the ground floor the railroad carts load and unload as well as remain under shelter, the horses being housed overhead. This arrangement is a healthy reversal of the old-fashioned plan alluded to above. The stables are ranged around the outer walls of the building in the form of a quadrangle, the center of which consists of an open well-hole covered by a glass roof. This roof is raised above the inner walls of the building so that an opening is left all around, through which a constant current of air passes up the well-hole from the street entrance on the ground floor. Moreover, each stable has windows in its outer wall fitted on the hopper principle. Running round the well-hole on each floor is a balcony, which is approached by two inclined ways, one on each side of the building, from the floor below. At the top of each inclined road, on the balcony, a water-trough is placed, so that the animals can be watered easily, both on entering and leaving their stalls. From each balcony admission is gained to the stables on its floor. These are divided in each case into seven sections, each of which has an opening to the balcony protected by a sliding-door. This enables each section to be isolated from the others in case of necessity, and, as the door slides on runners, it is impossible for a horse to get foul of them when entering or leaving its stall. Each section contains stalls for from ten to fifteen horses as well as a loose box for sick or vicious animals. The stalls are 9 ft. by 6 in. long by 6 ft. broad, and the loose boxes average 10 ft. by 12 ft. The average ground area allowed per horse is 90 ft., and the cubic space varies from 1000 ft. to 1440 ft. These dimensions meet the requirements of the best authorities on the subject. The inside walls of the stables are faced with glazed bricks, which are excellent both for light and cleanliness. Standing divisions made of pitch-pine are provided between the stalls. Swinging divisions are, perhaps, better for ventilation and sanitary reasons; but large horses, such as here housed, are apt to injure themselves against these. Each division is capped with iron to prevent crib biting, and a kicking board of elm, 6 in. wide, which can be renewed when worn out, is fastened close to the ground against the hither end of each partition. The mangers are of salt-glazed earthenware, and are made in two pieces, so that, if one is broken, the other is still available, and can be retained while the broken one is replaced. Flush boarding is nailed from the manger to the floor of the stall, so as to remove the risk of a horse injuring itself by knocking against the inside of the manger when rising from a recumbent position. No hayricks are provided, as chopped food only is given.

Architecture in India.

INDIA, from any point of view, presents more that is interesting to students than most other parts of the Orient. Its languages and dialects, mostly derived from one of the oldest known languages; its literature, art, religions; its architecture, manners, customs,—each and all have a picturesque character, transcending anything to be found among other eastern peoples. Its ancient architecture presents features of interest perhaps beyond anything to be found even in Egypt, that land of structural wonders. Interesting as it is, it has had little influence upon architecture anywhere else; nor has the influence of western architecture much affected the character of architecture in India, except so far as the English nation has planted upon the soil some of the incongruities of western styles, which, however, have never been adopted in any of the native architecture. Thus Indian architecture remains distinct and exclusive.

This and other points relating to Indian architecture are made the subject of a recent paper read by N. N. Waskelar before the Illinois Chapter of the American Institute of Architects, at Chicago, and serially printed in *The Inland Architect*, beginning in January. He asks: "Is it then worth while to go into India's architecture, when it is so exclusive, tangled in such intricate meshes? I think it not only deserves a passing notice, but a careful study. Greece and Rome, gentlemen, are dead and gone. India is a living reality. Although there have been influxes, there have not been refluxes. The result is that every art has its living representative, every science its illustration, and a majority of them not easily surpassed. The works of an immense portion of the human race who have shown themselves capable of artistic development must be studied; more so, when it is a living art and can only be seen in action in India."

The styles of Indian architecture are named as the Buddhist, the Jain, the Saracenic, the Mohammedan, the Pathan, the Hindoo Proper, and the Mogul; but in the paper a broad classification into the Buddhist, the Mohammedan, and the Hindoo, is adopted. Indian architecture "has been wonderfully developed since the twelfth or thirteenth centuries, during the Mohammedan period of India's history. It is not known to this day what was the composition of the ingredients used in building structures to make them so lasting. I know in ordinary towns structures are standing this day—for centuries, they say—with cracks from top to bottom, which don't give way. Stone not being used in remote ages, it is useless to look for any architectural remains till after the date of Gautama Buddha, 540 B. C., or rather of King Asoka, the disciple of Buddha, who reigned from 272 to 236 B. C., and who was the first to use stone in structures. Most remote of his relics now left are the Lats, or inscribed pillars, ornamented with bands and moldings crowned by a sort of capital. It has been surmised that these must have been approaches to Buddha's temples, now no longer found. Besides these, there are topes, which exist in numbers in India. These are either to note some notable occurrence, or to mark sacred spots, or to cover the relics of Buddha himself. Topes consist of a stilted hemispherical dome surmounting a circular structure, access to which is by steps with niches for the reception of sacred repositories. Central India is full of these, and the most famous of all is at Sanchi, about one hundred and twenty feet in diameter and sixty feet high. This was built by King Asoka. Of the various invasions which have overrun India, some have left traces in the architecture of India. Some semi-Greek forms are yet to be seen in the northern provinces,—undoubtedly the remnants of the invasion of Alexander the Great.

"Besides these, there are caves, temples, and monasteries hewn out of solid rock. The older monasteries cut in the rock are several stories in height, and it is probable that these cells must have been used by devout Buddhists for the purpose of meditation or habitation; but many of these—the Jain and the Brahminical temples—display rich ornamentation and very elaborate workmanship indeed. Intricate moldings and other fantastic embellishments abound in numbers. Columns of all shapes and sizes are found; brackets frequently used in lieu of capitals; and, where capitals are used, almost every variety of fantastic form is noticeable. Some say no fixed laws exist and govern these relics, but original works of great antiquity do exist which show plan of buildings, their heights and details; and these could not have been merely thought of."

Descriptions of special structures follow the general discussion, some of these structures being very remarkable, as notably the cave temples hewn out of solid rock, and profusely decorated with elaborate and artistic sculptures. Considerable space is devoted to the Mohammedan architecture, of which India affords numerous examples, often standing side by side with the Hindoo and Jain temples.

The McKaig Bill.

ALL the architectural publications printed in the United States are noticing, and are almost unanimously favoring, the bill relating to the reorganization of the government architect's office. The favor accorded to the provisions of this bill is entirely justified by the past work of the office, which loudly calls for thorough reorganization. Some of the work—we might even say a large part of it—has been such as to reflect anything but credit on the architectural skill of the country. The object of the proposed bill is to reduce the functions of the government architect's office to a routine of purely administrative duties, and to relegate the work of designing structures to a board of high character, which will distribute the work among the most skillful architects in the country. A letter addressed to President Cleveland and signed by the members of the executive committee of the Architectural League of New York has been widely distributed to the press, with another soliciting co-operation in securing the passage of the bill. In the letter to the president it is set forth that "the McKaig Bill represents the result of the joint efforts of the profession, and of those legislators and experts who have been working to reorganize the present methods and to establish new and better methods. In their judgment, this measure will accomplish the desired results in a wise and conservative manner, and will meet the requirements as nearly as any bill of general character can do." The results achieved at the World's Fair in Chicago are cited as evidence of what the architectural genius of this country is capable of doing, as contrasted with the disgracefully mediocre work of most of our public buildings.

We are informed that the bill originated with a few prominent and representative architects of New York city, who had learned that Secretary Carlisle favored a reorganization of the supervising architect's office. It was introduced into the house by Mr. McKaig, and into the senate by Senator Brice. It was drafted by architect George B. Post in consultation with the other architects mentioned, and also with the treasury department. How far the name, "supervising architect," has been justified by the workings of the office appears from the following extract from the report of the house committee, recommending the passage of the bill:

"The supervising architect rarely sees one of these government buildings while in course of construction. Its construction is generally under the supervision of some local carpenter or builder, who never made any pretence to architectural knowledge or study; whose appointment was secured, not because of his skill, but because of the political influence he could marshal, and whose greatest solicitude is to prolong the tenure of his employment by delaying the completion of the work. A building which, if the property of a private citizen, would be constructed in months, when erected by the government requires years for its completion. Of a public building at Detroit, Mich., where the construction was authorized eleven years ago, and $1,300,000 appropriated by Congress years since, the foundation walls are not yet completed. Indeed, the abuses in the method above referred to have become so serious that the committee cannot conscientiously recommend public buildings at many places where the economical and convenient transaction of business would justify such buildings, could they be provided at a cost not greatly exceeding the necessary expenditure by a private owner for similar purposes."

The report concludes with the statement that the measure advocated is intended to make the supervising architect "what the title of his office indicates, the supervisor of architects; not the government's architect, but the supervisor of the architects of the government's works."

Medieval Domestic Architecture.

MR. BARR FERREE, in a paper read before the Archæological Institute in Philadelphia on December 29, and printed in *The American Architect* (Jan. 12), calls attention to the value of medieval architecture as a study for architects of the present day, this value having been strongly impressed upon his mind by opportunities afforded him during his stay in France last summer. From his observations in France and a comprehensive scrutiny of architectural literature with the object of noting to what extent the dwellings of times prior to the Renaissance find a place in books, he positively asserts that "as yet there has been no general survey of the whole field of domestic architecture from the earliest times down to the end of the last century."

Disclaiming "actual acquaintance with ancient domestic architecture outside of France," Mr. Ferree says that, when he visited France, he was quite unprepared for the enormous number of houses of all sorts that he met with in his wanderings. "Not all of these were of historical value.

though their general effect, when seen up narrow streets, or in small bits, was intensely picturesque; a good deal has been injured by restorations, by rebuildings, and by repairs, until sometimes only a window-frame or a huge column remained to tell or to suggest what the original structure was like. By far the larger part of these ancient buildings are unstudied and unknown. Even the photographic series of the Commission of Historical Monuments contain but a few of them. For example: the new catalogue of M. Robert, the official photographer to the Commission, which has just been pubished, contains but seven photographs of the old buildings of the town of Montferrand, and two of these are details of whole structures included in the other photographers. This town of Montferrand, which is not inaccessible at all, being reached in a few minutes by electric railway from Clermont, is full of old houses, scarcely any building of importance having been erected there since the sixteenth century."

Whereas "M. Robert offers but four photographs" from subjects in Sarlat, 'one of the most picturesque and strange towns in France . . . he could have gathered forty easier than . . . to have picked out the four. . . . And I might take up ifty towns and make the same report on them: scarcely a village in France that does not contain some type of ancient house architecture of more or less interest. And while speaking of the subject of photographs, it may be well to mention that almost nothing is done by local photographers. In some localities where there are well-known curiosities that are visited by occasional tourists, small photographs can be had of scarce more value than the simplest souvenirs. Anything like adequate photographing by local photographers is quite unknown." Any desire for the evivification of ancient art is disclaimed by Mr. Ferree. His main object is to inlicate the exceeding richness of the field. A general scheme for the systematic study, llustration, and description of the domesic architecture of France by its numerous archæological societies is outlined. The favorable conditions for this line of study in France, assumed to exist also in other European countries, are: "(1) An enormously rich field, which (2) has scarcely been worked; (3) many important individual monuments have been studied, especially those of the Renaissance period; (4) what work has been done has been diffuse and without system; (5) a necessity for extended systematic study." There is small hope of this work being done by American architectural students. It will be a task involving more or less drudgery. "Earnest as many of these young men are, they want something striking to show for their work; it is the beautiful and the picturesque they are in search of. I doubt if much can be expected from them, through the uninteresting nature of much of the material to be studied. It is, further, work that requires long-continued labor to bring adequate returns. A study of a single building is scarcely likely to have the value that the study of a group in the same vicinity would have. It is, therefore, hardly possible, as the archæological outlook now is, to hope for much in this department from any but the French themselves. Whether it is in good form to suggest to them that this work needs to be done; whether it is advisable to advocate the general study of European domestic buildings throughout the whole continent,—I must leave to others to determine. My present purpose will have been accomplished when I repeat that in this one subject is an archæological field, close at hand and ready of access, of most amazing richness."

Decorative Iron Work.

THE revival in ornamental iron work is a noticeable feature in recent architecture. The increasing demand for art work in iron is now annually giving employment to a large number of people, and a better rate of wages is paid for such work than for ordinary iron work. In the *Iron Trade* (Jan. 3) the subject is discussed, and the date of the revival is placed about ten years ago. Whether the impulse given to art in iron is the outgrowth of the increased use of iron and steel beams and columns in buildings, as intimated, may, perhaps, be doubted. But it is unquestionably true "that the American artist-blacksmith has found not only a new but a much wider field for the exercise of his craft, and it may be truthfully said not only that he has achieved a success equal to that of the most notable of his ancestors, but that he outstrips him in the adjustment of relative parts and the exact and harmonious adaptability of his equally artistic conceptions to every given function. Nor has this frank concession to modern exigencies been in any degree detrimental to the esthetic element in his work, as in all the qualities constituting good design the modern is quite the peer of the medieval smith."

However, it may be admitted that the facility with which iron lends itself to decorative purposes in that struggle to make the most of space which characterizes the architecture of the large office-building has had much influence upon the recent development of the art. "The high office-building has not only afforded our smith the opportunity, but has presented a problem to be solved only through his instrumentality; the elevator equipment, the displacement of wood and marble by the more graceful, pliant, and space-economizing iron, are in point, while the grille, from having been almost exclusively used in the church and cathedral, is now being set up in secular temples to guard the money-bags of commerce and trade, as in its earlier use it had been at once the reliquary and ornament of the church. The massive and gloomy corridors of the public and commercial structures of twenty years ago have given place to light and airy passage-ways, and this is largely due to the substitution of ornamental iron for other material, as a study of any one of the more modern, up-to-date structures will show."

Another reason for the sudden increase in the use of iron, both for interior and exterior decoration, may be found in the invention of processes for protecting iron from atmospheric influences,—processes of which medieval artists in iron were ignorant. Among these the Bower-Barff process stands prominent. Ornamental brass-work is also sharing in the revival, which seems to indicate the increased use of iron in buildings is not alone the cause of the increased favor in which metal art work is now held.

Decorative Hints from Frost.

MR. LESLIE RAMSEY, in *The Plumber and Decorator*, calls attention to the fact that the rich variety of organic forms, affording so many suggestions for design, has caused the likewise rich variety of inorganic forms to be comparatively ignored. Among the inorganic forms containing innumerable suggestions for designs are frost-forms on window-panes, and to these special attention is directed. He has also worked out some of these hints into designs for panels, wall-paper, etc., which indicate how fruitful these frost-painted panes may be, when treated by an artist in design. The frost-decoration of trees and shrubs is, much of it, strikingly beautiful, and Protean in variety. The great variety of beautiful forms presented by crystals of snow offers still further hints of decorative design; and, although all these forms are in themselves destitute of color, the refraction of light transmitted through them, or their illumination by artificial means, will supply color-effects of great beauty.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*28371. Recent Architecture in France. Ill. Barr Ferree (E Mag–March.) 3000 w.

†28389. The Steel Construction of Buildings. C. T. Purdy (B U W–Vol. I, No. 3.) 9500 w.

28429. Determination of Stresses in an Irregular Truss. George H. White (E R–Jan. 12.) 700 w.

28430. The Miller Stable, Buffalo, N. Y. Ill. (E R–Jan. 12.) 2500 w.

28432.—75 cts. Editorial Review of Paper by Thomas Hastings, on "High Buildings and

Good Architecture" (A Rev–Vol. III, No. 5.) 2400 w.

28433.—75 cts. Traveling Scholarships. C. H. Blackall (A Rev–Vol. III, No. 5.) 5600 w.

*28440. G. E. Street as a Draughtsman. Ill. B. (A L–Jan. 4.) 1500 w.

*28480. Decorative Hints from Frost. Ill. H. Leslie Ramsey (Pl D–Jan. 1.) 1000 w.

*28484. Decorating the Dining-Room (I C B–Jan. 4) 1500 w.

28486. The Study of Mediæval Domestic Architecture. Barr Ferree (A A–Jan. 12.) 2700 w.

*28493. Fountains Abbey. Ill. Anon. (B–Jan. 5.) 4500 w.

28555. About Chimneys. Fred. T. Hodgson (A & B–Jan. 19.) 4600 w.

28568. Thomas Jefferson, Architect. John Kevan Peebles, in the Alumni Bulletin (A A–Jan. 19.) 3800 w.

*28585. Window Glass. Anon. (I C B–Jan. 11.) 2500 w.

*28606. The Evolution of Ornament. (Extract.) George Coffey (A L–Jan. 11.) 4000 w.

*28611. Bedford Stone—Its History, Production and Popularity. Ill. (S–Jan.) 14500 w.

*28613. London Stables. Anon. (I C B–Jan. 11.) 1300 w.

*28633. Architectural Illustration. C. G. Harper (B A–Jan. 11.) 4800 w.

28699. Fireproofing Processes and Fireproofing Paints (E N–Jan. 24.) 1100 w.

28717. Specific Recommendations of the Tenement House Committee (A & B–Jan. 26.) 700 w.

*28760. Roofing Slate. Extracts from H. Brunner (I C B–Jan. 18.) 1300 w.

*28766. The Red Brick Order of Architecture (I C B–Jan. 18.) 1100 w.

*28774. The Study of Buildings To-day and in the Past. F. C. Penrose (B–Jan. 19.) 5500 w.

*28776. Hallam on the Progress of Domestic Architecture (A L–Jan. 18.) 5500 w.

*28804. Skeleton Construction. Fireproofing. Foundations. P. B. Wight (B B–Jan.) 1200 w.

*28807. Concrete in Cold Climates. Ross F. Tucker (B B–Jan.) 900 w.

28948. House Decoration. G. Jekyll (Sc A S–Feb 2.) 4800 w.

†28994. Narrative Report on the Underpinning of the Calcutta High Court Buildings. Ill. Charles Warde (I E–Dec. 29.) 1500 w.

*29004. The Church of St. Mary, Harrow-on-the-Hill. Ill. Anon. (B–Jan. 26.) 4000 w.

*29005. Bricks and Brickwork. John Slater, with Discussion (B–Jan. 26.) 1700 w.

*29009. Architectural Conservatism. Anon. (B A–Jan. 25.) 600 w.

29111. Tests of Melan and Other Arches.—Made in New York by Mr. George Hill (R G–Feb. 8.) 400 w.

29124. Government Architecture — Letter from John M. Carrère (A & B–Feb. 9.) 1200 w.

29125. Sir C. L. Eastlake on the Decoration of Houses. From the Architect, London (A & B–Feb. 9.) 6000 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (A & B–Began May 6, 1893—39 parts to date—15 cts. each).

18737. The Engineering of Architectural and Building Construction. Ill. William H. Burr (E R–Began Jan. 6, 1894—9 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. (S–Began Jan. 1894—11 parts to date—30 cts. each).

19218. Manhattan Life Insurance Building, New York City. Ill. (E R–Began Jan. 20, 1894—6 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (B B–Began Jan. 1894—13 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (A A–Began April 14—12 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B–Began April—9 parts to date—30 cts. each).

25177. Colonial Architecture in Western Massachusetts. Ill. George C. Gardner (A A–Began Sept. 15—3 parts to date—15 cts. each).

26069. Modern Steel Fireproof Construction. Ill. F. M. Small (A & B–Began Oct. 13—4 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (I C B–Began Nov. 9—5 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. George Ashdown Audsley (A & B–Began Nov. 24—3 parts to date—15 cts. each).

27297. Strains in Compound Framed Structures. Ill. Francis Schumann (A A—Began Dec. 1—3 parts to date—15 cts. each).

27924. The Modern Theatre of the Continent. Edwin O. Sachs (B A–Began Dec. 14–Ended Jan. 25—5 parts—30 cts. each).

28018. Concretes, Cements and Mortars: Old and New. Fred. T. Hodgson (B B–Began Dec.—2 parts to date—30 cts. each).

28152. Reference Books in Architecture. Herbert Batsford (B A–Began Dec. 21—3 parts to date—30 cts. each).

28494. Bricks and Terra Cotta. Anon. (B–Began Jan. 5—4 parts to date—30 cts. each).

28556. The Treatment of Sculpture in Relation to Architecture. John Begg (A & B–Began Jan. 19—Ended Jan. 26—2 parts—15 cts. each).

28582. Architecture in India. N. N. Waslekar (I A–Began Jan.—1 part to date—45 cts).

28803. The Pen Drawing of Brick Architecture. Ill. Bertram G. Goodhue (B B–Began Jan.—1 part to date—30 cts).

28805. Fireproof Floor Arches. George Hill (B B–Began Jan.—1 part to date—30 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Draining the Zuyder Zee.

IN point of time and money required for its accomplishment, the proposed drainage of the Zuyder Zee is the grandest engineering scheme now contemplated. A work which it will take 33 years to execute, and which will cost more than $127,000,000, is not to be thought of lightly, even in this age of great engineering achievements. This scheme, discussed at length in *Engineering* (London, Jan. 18), has been proposed to the Dutch government by the Royal Commission appointed to consider the best method of draining and utilizing a large part of the submerged area—once a part of the main land—now covered by these waters. Though land reclamation has figured largely in Dutch engineering, the present scheme is very far beyond anything yet attempted by that enterprising nation, if not in the history of the world. There is no question, from an engineering standpoint, as to the practicability of the work; the only doubt seems to have been whether it would be wise financial policy for the Dutch government to incur the enormous expense involved in the completion of the project. However, it seems likely that this question will be decided in favor of the undertaking, and the next generation of Dutchmen will probably see much of this submerged area wrested from the dominion of the sea. The plan comprehends the reclamation of no less than 750 square miles, which can be used for agricultural and other purposes. From the above estimated cost it may be computed that, in order to reimburse the expense of the work to the government, the reclaimed land would need to be sold at about $250 an acre, assuming that interest has been taken into account in making up the estimate. But the chances are great that the estimated cost may be exceeded before the work is completed; and, if the actual value of the land were the only incentive to the carrying out of the scheme, it would probably not have met with the favor that the Royal Commission has accorded to it. But "on the broader considerations of national progress—in the expansion of territory, in the increase of trade and agriculture, and in the giving to thousands of people the opportunities of profitable employment—the scheme, vast and costly though it be, is one that will certainly recommend itself to patriotic Hollanders, and insure for them, should they carry it out, the gratitude of future generations. . . . From an engineering point of view the most interesting part of the scheme is the construction of the great northern embankment, which is to shut out the ocean and change the region in question from a branch of the sea into an inland and eventually fresh-water lake. After a good deal of consideration, in the course of which six different lines of direction were examined, the commission decided to recommend that this embankment should begin on the north-west coast opposite the island of Wieringen, and in the first place join that island to the mainland, thus closing the neck of the sea known as the Amstel-diep. Commencing again on the western point of Wieringen, the embankment would stretch nearly 25 miles right across the Zuyder Zee to the coast of Friesland, where it would join the land again at Piaam. This embankment is not only to shut out the sea, but is to form a public highway between North Holland and Friesland, and is to afford space also for a railway connecting two portions of the Netherlands between which, save for a very wide detour, communication can now be carried on by water only. In order to fix the height of this embankment, the Royal Commission had first to consider what possible sea levels must be provided against, judging from past experience The greatest height known to have been attained by the sea waves along the coast of the Zuyder Zee was in December, 1883, when, during an extremely severe storm, the sea rose near the Noorderkijk of

Drechterland, at Andijk, to a height of 2.30 meters above the sea level at Amsterdam, while the waves ran up to the summit of the embankment there, a height of 5 meters, and washed away the gravel-road. The average height of the new inclosing embankment has, therefore, been fixed at 5.40 meters,—that is to say, it will commence at 5.20 meters on the western side, and rise gradually to 5.60 meters at the eastern side. It is thus believed that the summit of the embankment will be safe even during the severest storms that are likely to occur. The island of Wieringen will be protected by an embankment of similar height."

The further details of the work occupy some six columns of *Engineering*. Only one of these, the reclamation of the land, after the great embankment is complete, by the drainage of the polders, of which there will be four, can be noticed. "Along the outer line of the space to be reclaimed, in each instance, a dyke will be constructed, powerful enough to keep out the force of water represented by the Yssel Meer, such dyke being much about the same in form and character as the northern embankment, though of course it will not require to be so strong as the one that is to keep the ocean itself in check. Each dyke will be broad enough to have its roadway and pumping stations, and, as soon as it is ready, these stations will be built, and the pumping engines will be set to work to pump the water out of the inclosed space into the Yssel Meer. As already mentioned, a great deal of the Zuyder Zee consists of shallow sandbanks, and it will not be long, when the pumps are in full working order, before these banks appear above the surface of the water. As soon as a certain space is cleared, it will be surrounded by a small embankment, and form the first section, on which operations with a view to preparing it for agricultural purposes may be commenced at once, while the pumps are operating on the lower parts of the large inclosed space that are still under water. So the work will go on until the whole of the space inclosed by the main dam of the polder has been laid dry, and the different sections of that polder, each with a separate embankment of its own, and varying in shape according to depth, have been completed. The polders will, of course, be fully protected from any inflow of water from the Yssel Meer, while the drainage of an expanse of land which will lie considerably deeper than the surface of the lake shut out from it will be secured by a network of canals of various dimensions and at different levels, the water being pumped from the lower into the upper levels, until it can run into the Yssel Meer, and thence, through the sluices, into the sea." Mr. C. Lely, for a time chairman of the Royal Commission, and who has also filled the post of minister of the war department for the Dutch government, is credited with being the projector of all the essential features of this great enterprise.

Famous Bridges.

A RAPID review of the famous bridges of the world, past and present, is given by Mr. Robert Jamison in the *Chautauquan* for February. The first bridges were not bridges, in our now accepted meaning of the term, but piles of stones and logs, thrown into streams, over which people could pass by stepping from one to the other. These piles of rubbish were, however, the parents of the more modern masonry piers for bridges; and, when it was discovered that by laying poles or timbers from one pile to another the piers could be placed at a wider distance from each other and a continuous roadway constructed, the bridge as it has been known for ages had its birth. The next step was to connect the piers by arches, and for centuries far the greater number of bridges were thus constructed. The engineering genius of the present century has produced a variety of forms, among which are truss bridges, tubular bridges, suspension bridges, and cantilever bridges.

"Bridges of wood are mentioned as early as 1200 B. C. Homer refers to them also, and the first bridge built in Rome appears to have been built about 600 B. C. These early bridges were probably simple pile bridges, such as may be seen over many small streams in this country. The oldest bridge in existence in England is believed to be a bridge on Dartmoor. It consists of simple masonry piers with flat sides of stone for beams on top, and is thought to be about 2000 years old. Arched bridges of solid masonry were built by the Romans all over Europe. One of these, built at Alcantara, Spain, about A. D. 104, still shows by its ruins that it must have been in its day a very famous bridge. It was 670 feet long and 210 feet high, and consisted of a series of six arches of different sizes. The many great aqueducts built by the Romans were true bridges, and in their very ruins testify to the skill and courage of their great builders. The contest between the bridge and the boat is probably very old, for the Romans learned the art of making drawbridges (which were simple lifts) to allow boats to pass the bridge. The Chinese were also great bridge-builders since the very earliest times. The records of their great bridges are not very definite; yet it is clear they knew how to make masonry arches of great height and span.

"After the Roman bridges, there came many others of both wood and stone. A masonry arch bridge, founded by St. Benedret at Avignon in A. D. 1177, consisted of eighteen arches, the bridge being bowed upstream to resist the current. It was many years in building, and, like nearly every old bridge in Europe, was destroyed in some war. Old London Bridge was regarded as one of the wonders of the world. It had nineteen stone arches and was covered with buildings, except at the middle where the draw was placed. It was commenced A. D. 1176, and was not completed till 33 years after. The longest single span arch is said to have stood at Tresso. The bridge had a span of 251 feet and was 87 feet high. It was built in 1380, and was a famous bridge in its day. Nothing now remains except a small portion of the arch."

The "Bridge of Sighs" in Venice, which spans a narrow passage-way between a courthouse and a prison, is considered the most famous bridge in Europe; but it is for historical reasons rather than its engineering features that this bridge has become so widely known. Other bridges are famous for battles fought at or near them. The greatest impulse the art of bridge-building ever received was from the enormous demand for bridges and viaducts created by railroads. High and strong bridges were required, and, as in the United States, in the earlier stages of railroad building, it was necessary to use wood for bridge structures, the country became famous for its wooden trestle bridges, which were the forerunners of the steel structures now supplanting wood and masonry bridges on railways.

"In looking over the gigantic structures erected within the past 20 years, it is difficult to say which is the most famous. Britannia Bridge, in its day, was world-famous. To-day it seems insignificant and almost foolish in point of cost and weight. Why make a huge iron box, when a spider-web structure of steel would carry the same load at far less cost? A bridge may be famous for its unusual construction, like the great Pontoon Bridge over the Húglí at Calcutta. It is 1530 feet long, and is supported on 28 iron boats coupled together in pairs, the roadway being carried on timbers erected on the decks of the pontoons. The bridge was erected in 1873, and is justly regarded as the most important floating bridge in the world. Another may be famous for its great length and immense traffic, the Elevated Railroad in New York (which is a true bridge) being an example. Another may be famous for its bold and rapid erection, as the celebrated Kinzua viaduct on the New York, Lake Erie, and Western Railroad. This bridge is 2052 feet long and 301 feet high, and is supported by 20 open-work towers of iron. The 1750 tons of iron posts, struts, and braces were distributed over the steep rough valley, erected by means of steam derricks and a force of 125 men, and the structure completed between May 5 and August 29. The entire structure, including the laying of the foundations, was built in 8½ months, and the cost was $275,000. Comparing this with the celebrated railroad masonry viaduct over the Göltzsch Valley on the Saxon Bavarian State Railroad, we find that the German bridge, which is 1900 feet long and 263 feet high, cost $1,680,000 and over 5 years of abor. There can be no question as to which s the cheaper and better in a commercial sense. The Göltzsch bridge would be by many regarded as the most beautiful and the most permanent; yet it must be observed that the airy, thread-like structure of the Kinzua Valley has a strange, fascinating beauty of its own, and it may outast the big stone viaduct, for, in an earthquake, the stone bridge would come down irst. Regarded as a simple bridge, it is plain that the stone bridge will not be the type of the future bridge; cost settles that. The railroad bridge is for the people, and the people must be transported cheaply."

The most famous suspension bridges are the Niagara and Brooklyn bridges, and the atter is the most famous bridge of its class n the world. The Tower Bridge, in London, is one of the most interesting of recently-erected bridges. It is a combination of a suspension bridge and a drawbridge. Its cost was $5,000,000.

A Famous Bridge-Builder.

THE recently-elected president of the American Society of Civil Engineers, Mr. George S. Morison, of whom a biographical sketch with portrait is printed in *The Railroad Gazette* (Jan. 18), has probably had as extensive an experience in the construction of bridges as any other engineer, past or present, notwithstanding he has turned his attention to a wide field outside of bridge-building. "He built, as chief engineer, nine bridges across the Missouri in the interval from 1887 to 1893. The last of these were the bridges at Bellefontaine, Mo., and Leavenworth, Kan., both of which were completed in 1893. He built three bridges across the upper Mississippi in the four years 1890–1893, inclusive, the latest of these being the Alton bridge, and one of them, the Burlington bridge, having been rebuilt. He was also consulting engineer of the St. Louis Merchants' bridge. The greatest of his bridges, however, is that across the lower Mississippi at Memphis, completed in 1892. This has a main span 790.42 ft. long, and two river spans of 621 ft. each. The total length of the bridge proper is 2,597 ft., and, including the viaduct approaches, 4988 ft. There are but two bridges in the world with longer trussed spans,—the Forth bridge, with two spans each 1710 ft. long, and the Landsdowne bridge (Sukkur), with one span of 820 ft. Only one other bridge has reached such a great depth by pneumatic caissons,—the Eads bridge at St. Louis. The table below gives the depths reached and the greatest immersion while work in the caissons was in progress:

	Below l. w.	Below h. w.	Immersion.
Memphis....	96.2 ft.	130.8	108.
Eads........	94.	135.5	109.7

"In this work singular difficulties were met by highly original methods.

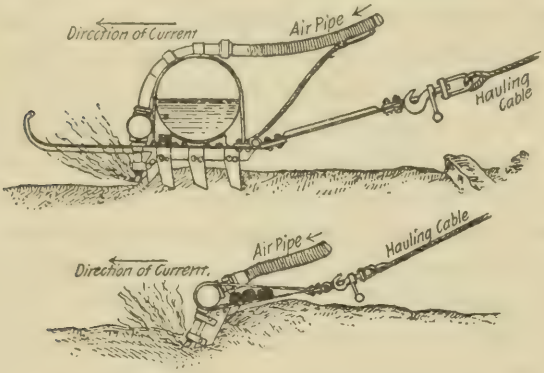
"Mr. Morison also built a bridge across the Ohio river at Cairo; . . . . one across the Willamette at Portland, Ore.; one across the Snake river at Riparia, Wash.; and one across the St. John's river at Jacksonville, Fla. Besides these, he has built a good many smaller bridges and viaducts for various companies. The aggregate length of his large bridges is about five miles. Within the last year he served as one of the Board of Engineers appointed by President Cleveland to report on the project for bridging the Hudson river at New York.

"The Missouri is one of the most troublesome of all the great rivers of the world. Its swift current, changing channel, and treacherous bottom unite to make it the dread of engineers. In the nine great bridges which Mr. Morison has built over that stream unexampled combinations of difficulties came up. In this work, as in all the other bridge work which has been specified above, on streams offering a great variety of physical conditions, Mr. Morison was the actual chief engineer, controlling everything to the last detail."

Dredging with Compressed Air.

A METHOD of dredging with compressed air is described in *Engineering News* (Jan. 17), with illustrations from *Le Génie Civil*, herewith reproduced. The principle was first used by a Mr. Wheeler, in 1893, for dredging mud from the port of Tilbury. The apparatus illustrated is, however, from designs of Mr. Moorman, and for use in the lower channel of the Weser river.

Mr. Wheeler "based his original deductions upon the fact that in dredging there are two distinct operations,—the loosening of the material from its bed and its removal. In fine materials, like mud, or sedimentary matter, which can be carried in suspension by the current, this current is often depended upon to transport it after it is artificially stirred up. But the velocity of transportation is often feeble, depending upon that of prevailing currents; and the distance of transportation depends upon the height to which it is possible to lift the solid particles in the stirring process. With this in view Mr. Wheeler made a series of experiments at Tilbury, founded upon the theory that the resistance of gravity, for any particle transported in a current of water, was proportional to the velocity of this current; and that in a vacuum, with an initial horizontal velocity given to a particle, the distance to which the particle would be carried was proportional to the square root of the height at starting, as the path would be parabolic. It was then evident that in attempting to remove mud by stirring, when there was little natural current, it was essential to lift the mud particles artificially as high as possible. At Tilbury a water jet was used for this purpose; but on the Weser compressed air was applied to this end, as here shown."



Compressed Air Dredging Apparatus.

The apparatus, as shown in the engraving, is remarkably simple. Its elements are "a plow and an air conduit. This plow, for mud of very little consistency, was built of light iron, and was provided with a cylindrical float which prevented it from sinking into the mud beyond a certain depth. It was equipped with a series of plowshares and drawn by a cable worked either from the bank or drawn from a boat. While it is moving, air is forced into a pipe fixed upon the rear of the carriage and provided with several vertical nozzles. As this air escapes from the nozzles, it agitates the water up to the surface, even in depths of from 23 to 26 ft., and gives an impulse to the water particles that is felt for 'several kilometers' of distance in a very feeble current.

"When the bottom is of stiffer mud, the number of shares on the plow is reduced, and the float is replaced by a load of castings or a block of stone. This apparatus is claimed to possess important advantages over the floating dredge, especially when employed at sea, because it can be advantageously used in stormy weather and rough water, when the ordinary dredge would be entirely unavailable. As to the choice to be made between water-jets and compressed air, the inventor prefers the latter. Not only are the air-compressors and conduits required less cumbersome than if water were used for the same work, bnt the air leaving the nozzles, beside acting upon the loosened mud on the bottom, has a tendency to lift the muddy particles towards the surface, and thus increase the distance of transport. The effect of the water-jet is almost wholly expended upon the bottom material, and comparatively little power is left to aid in transport." The results of this method will be awaited with interest.

The Chicago Canal and the St. Lawrence River.

Mr. Charles Baillargé, C. E., of Quebec, discusses, in *The Canadian Architect and Builder*, the effect on the commerce of the St. Lawrence which will be produced by the Chicago drainage works now in progress of construction; and he enters into a calculation to show that this effect will be injurious. The canal will run 10,000 cubic ft. per second. "On the other hand, Niagara runs 18,000,000 cubic ft. of water per minute from Erie and the upper lakes into Ontario and the St. Lawrence, or 300,000 cubic ft. per second." From these data it can be easily seen that the flow through the St. Lawrence will be diminished by one-thirtieth ; and this is the basis for an assumption that the depth of the river will be decreased by the same fractional part, "which, even on the channel of St. Peter, must tell against the present draft of ocean steamers."

But this is only a beginning, in the opinion of Mr. Baillargé. "Chicago, whose population is now but two millions, or close upon that, in the near future may and likely will swell to six millions in another half or quarter of a century, when the canal will have to be enlarged to take the then increased drainage from the city with its percentage of diluting waters from Lake Michigan, in a way to run fully three times the quantity at present legally permitted. And that it may not be inferred that this is a gratuitous supposition, I have to remind your readers that extension has already been provided for in effecting the specifications necessary for the right of way. The ultimate flow through the canal will then probably be 30,000 cubic ft. per second, instead of only 10,000, and diminish by one-tenth the Niagara outpouring, and also by one-tenth the depth of flow of the St. Lawrence,—though by less below Montreal, due to such tributaries as the Ottawa, the St. Maurice, the Richelieu, and other side-issues,—thus seriously affecting the present possible draft of vessels through Lake St. Peter, with a demand by our friends of Montreal and westward for a further dredging of the channel by some 3 ft., or 10 per cent., to make good the loss in flow, to say nothing of the fact that other portions of our maritime highway from the Great Lakes to the Ocean must suffer in a like manner by forcing us to go back to river craft of less capacity."

Strangely, while " western traders east of Chicago" begin to see this, "the Montreal, Quebec, and other chambers of commerce and boards of trade have not, as yet, in any way alluded to the fact in any of their transactions." The question is raised whether one nation can legally "rob another of its God-given resources any more than" an individual can impound and cause to deviate the waters of a stream or any notable portion thereof, without having, as bound by law, to turn them back into the same natural bed or channel for the use of his next neighbors on a lower level.

A danger is also pointed out as likely to come in on the Huron and St. Charles above the dam, on account of increase of water, whereby lands that can now be cultivated may be submerged. Any increase of water in the Mississippi is also regarded as an increased menace to the levees, which are even now tried almost to the limit of their resistance during times of flood.

Cost of Macadam.

INTERESTING particulars of the cost of maintaining macadam roads in Berlin are given in *Paving and Municipal Engineering* for February. In the United States the use of macadam roadways in cities has not been so extensive as abroad, although for suburban roads and much-traveled roads in populous districts they have been considerably in vogue. The construction of such roads has, therefore, been placed largely in charge of civil engineers not directly connected with municipal departments. Berlin, on the contrary, has most of its principal streets paved with macadam, and the average cost of maintenance of these roads will be generally interesting to civil engineers, whether engaged in municipal work or otherwise. No less than 1,280,796 square yards of macadam have been laid in the streets of Berlin. Twelve of these streets are specifically selected, and the average cost of maintenance for each entire street is given. The lowest average annual cost of maintaining these roads, per square yard, is $0.112, at which figure two only of the streets in the list were maintained. The highest average cost (only reached on one street) was $0.365. The average for all the streets in the list, computed from the respective averages, is $0.21533. The first cost of telford or macadam roads is about the same as in other European cities. The cost of maintenance of macadam is estimated as two or three times that of asphalt roads. This is accounted for by the better character of the repair work done in Berlin which really amounts to a thorough renovation, an example that might well be imitated in American cities, which, however it will be hopeless to look for until all public engineering work can be divorced from politics.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

28542. Recent Small Bridges on the Baltimore and Ohio. Ill. (R G–Jan. 18.) 2000 w.

28592. The Gaspee Street Bridge, Providence, R. I. Ill. (E R–Jan. 19.) 1300 w.

*28605. Old London Bridge (Extract.) Charles Welsh (A L–Jan. 11.) 3300 w.

*28641. Famous Bridges of the World. Robert Jamison (Ch–Feb.) 4000 w.

28696. A Novel Swinging Foot Bridge. Ill. (E N–Jan. 24.) 600 w.

29084. A Bridge Works' Rules for Drafting Room Work. Charles H. Wright (E N–Feb. 7.) 4000 w.

29094. Electrically Operated Rolling Lift Bridge, Van Buren street, Chicago. Ill. (W E–Feb. 9.) 2500 w.

29133. The Theory of the Suspension Bridge. R. W. R. (E M J–Feb. 9.) 2000 w.

Canals, Rivers and Harbors.

*28375. Causes of Floods in Western Rivers. Ill. Charles B. Going (E Mag–March.) 3000 w.

*28462. Harbors and Waterways. Editorial Review of 1894 (Eng L–Jan. 4.) 3200 w.

28587. The Chicago Drainage Canal—Messrs. McArthur Brothers' Contract (R A–Jan. 18.) 3800 w.

*28646. Effect on the St. Lawrence of the Proposed Deviation of a Portion of Its Waters Toward the Gulf of Mexico, by the Chicago Canal Now in Process of Execution. Charles Baillairgé (Can A–Jan.) 1000 w.

†28658. The Rivers of the Punjab. Ill. E. A. Sibold (I E–Dec. 22.) 1500 w.

†28659. Improving the Navigability of a River by Training. H. Engels (I Eng–Dec. 22.) 1000 w.

28677. Erie Canal Improvement. Editorial (A M–Jan. 24.) 900 w.

*28730. The Suez and the Manchester Ship Canals. E. Leader Williams (C G–Jan. 18.) 5400 w.

*28749. The Nicaragua Canal Scheme (Tr–Jan. 18.) 1300 w.

28889. The Brazos River Harbor Works (E N–Jan. 31.) 900 w.

28895. Dredging With Compressed Air. Apparatus of Mr. Moormann. Ill. (E N–Jan. 17.) 700 w.

29078. Improvements in New York Harbor during 1894 (Sc A–Feb. 9.) 600 w.

*29083. The Inland Waterways of Germany (Tr–Jan. 25.) 2500 w.

29129. An Exclusive Stadia Method of Making River Surveys. (Abstract.) J. L. Van Ornum (E R–Feb. 9.) 1400 w.

Hydraulics.

28893. Movement of Water Over a Dam with Wide Horizontal Top. Ill. Edward N Pike, with Reply from J. P. Frizell (E N–Jan. 31.) 1300 w.

28894. On the Flow of Water Over Weirs with Rounded Crests. Ill. N. Werenskiold, with Reply from J. P. Frizell (E N–Jan. 31.) 2500 w.

Miscellany.

*28459. Civil Engineering. Editorial Review of 1894 (Eng L–Jan. 4.) 5400 w.

28695. The Puget Sound Dry-Dock, Port Orchard, Washington. Ill. (E N–Jan. 24.) 1200 w.

*28721. The Draining of the Zuyder Zee. Ill. (E–Jan. 18.) 3000 w.

†28789. Specifications for Portland Cements and Cement Mortars. Frederick H. Lewis (P E C P–Jan.) 13000 w.

28882. The Sandy Lake Dam and Weirs. Ill. (E R–Feb. 2.) 2300 w.

*28971. Brandt's Rock Drills. Ill. (Eng L–Jan. 25.) 1100 w.

29003. George S. Morison, President of the American Society of Civil Engineers (R G–Jan. 18.) 800 w.

*29042. Civil Engineering in 1894 (E Rev–Jan. 21.) 2500 w.

*29065. Vibrations of Dams. E. R. Beardsley (Am M–Feb.) 600 w.

29085. American Types of Movable Dams and their Development. Ill. Hiram M. Chittenden (E N–Feb. 7.) 3500 w.

Serials.

26914. Waterways versus Railways (R A–Began Nov. 16—6 parts to date—15 cts. each).

28458. The Simplon Tunnel. Ill. (Eng L–Began Jan. 4—4 parts to date—30 cts. each).

28495. The Blackwall Tunnel. Ill. Anon. (E–Began Jan. 4—1 part to date—30 cts).

28498. Thames Bridges. Ill. Anon. (E–Began Jan. 4—2 parts to date—30 cts. each).

28615. The Nebraska City Bridge. Ill. (E Began Jan. 11—Ended Jan. 25—2 parts—30 cts. each).

28662. Practical Bridge and Girder Construction. Anon. (M W–Began Jan. 18—1 part to date—30 cts).

Explosions of Kitchen Boilers.

IT has been claimed that by letting cold water flow in upon a boiler surface heated to redness, steam may be generated so rapidly as to burst the boiler. So far as this belief applies to kitchen boilers, the question was brought before the Manchester (Eng.) Steam-User's Association in 1867, and a description of experiments (well-nigh conclusive as against this view) was presented to that body and republished in *Engineering* and other English papers. Further experiments were made from time to time with a view to a final settlement of the question, and it now appears that the holding capacity of a boiler would have to be very small in proportion to the heated surface in order that pressure enough to burst it could be thus generated.

Experiments with a Lancashire boiler showed that with a boiler of that type the maximum pressure attainable by letting water flow on and over the tops of its red-hot flues was 27 lbs. per square inch. Here the cubic capacity was large as compared with the heated surface. The class of boilers known as "kitchen boilers" in England offered perhaps the extremest case of extent of surface that could be heated to redness as compared with cubic capacity, and it was justly thought by Mr. R. D. Munro, the chief engineer of the Scottish Boiler Insurance and Engine Inspection Company, Limited, that experiments with this type of boiler, if carefully performed, ought to settle the question practically and finally. The results of these experiments have been printed in a small volume, reviewed in *Engineering* (Jan. 4) under the title "Domestic Boiler Explosions." The experiments of Mr. Munro fully confirm the view that it is impossible to make a boiler explode by raising it to a red heat and turning cold water into it. "It may be cracked, or a side may open, but no explosion in the proper sense of the term takes place, a very small aperture being sufficient to pass all the steam generated."

"For the purpose of these experiments, a wrought-iron cylindrical shell, about 20 ft. long and 6 ft. diameter, was prepared and erected with its axis vertical. The boiler to be tested was placed inside this, so as to prevent damage being done if an explosion did occur. A furnace was fitted inside this shell, and over it was placed the boiler to be tested. The boilers experimented upon were taken from the general stock of the different makers, and were fair samples of the ordinary domestic boiler. As a preliminary, a series of experiments were made to determine the size of safety-valve necessary to prevent a rise of pressure above that corresponding to the load on the valve. With a so-called 'boot' boiler, having a capacity of 14 gallons and weighing over 160 lbs., it was found that a dead-weight safety-valve, ½ inch in diameter, was capable of passing all the steam which it was possible to generate. In making the experiments with the 'red-hot' boiler, it was found that a suitable safety-valve was again effective in preventing any serious rise of pressure, even when fully three-quarters of the whole surface of the boiler was raised to a red heat.

"In the first of these experiments the safety-valve was loaded to 10 lbs., and, on turning on the water, the pressure due to the steam generated by the hot surfaces rose to 12 lbs., after which it fell again to 6 lbs., which was due to the head of water in the supply-pipe. The steam produced apparently cleared the boiler of water, but in a few seconds a supply of water gained access to the boiler, sending the pressure up again to about 12 lbs., after which it fell below that due to the head. The 'geyser' action again recurred, a larger supply of water reaching the plates than in the previous case, with the result that a pressure of 16 lbs. was indicated on the maximum gages."

These experiments were varied in a great many ways. When the valve was loaded to 20 lbs., and "the boiler was made nearly white hot," and when water was forced in under a head of 12 lbs. per square inch, the pressure rose to a maximum of 44 lbs., and, steadily falling, was below the safety-valve load at the end of 22 seconds. Some distortion resulted, and a stay was started. The most decisive experiment of all, however, was the following:

"The safety-valves were locked fast, and the boiler heated as before. On turning on the water, the pressure gradually rose up to a maximum of 118 lbs. per square inch, when a part of the boiler gave way. There was, however, no explosion, a weld simply opening and letting the steam out quietly. The experiment was then repeated with a second boiler, which failed at 90 lbs. per square inch. As before, there was no explosion, there being no reserve of highly-heated water to keep up the pressure, as is necessary for a true explosion to occur. The boilers were not even shifted on their beds. Mr. Munro points out that, in many towns, a domestic boiler is quite as likely to run dry in summer as in winter, owing to the water supply being intermittent; but he has only found one case of a domestic boiler exploding in summer, and that was proved not to be due to shortness of water. In winter such explosions are frequent, and, in view of all the experiments which have now been made, it can hardly be doubted that they arise simply and solely from the plugging of the outlets, and that a suitable safety-valve forms a perfect guarantee against danger."

Greenhouse Heating.

It is probable that comparatively few people are aware of the increasing extent to which dwellers in cities are supplied with table luxuries and floral adornments by cultivation in greenhouses. And as the power to gratify luxury among the wealthier classes increases, the conservatory becomes every year more in demand as an adjunct of the modern house, both in city and country. Success in greenhouse culture depends more upon judicious heating and ventilating than upon anything else except the maintenance of a proper hygrometric condition of the atmosphere and the necessary supply of water to the plants. In fact, if to the two requirements named we add the preparation of the soil used for potting and bedding, and the protection of plants from insect enemies, we have all the principal essentials for successful greenhouse culture.

In a paper read before the New York Florist's Club by Mr. Samuel Burns, member of the American Society of Heating and Ventilating Engineers, and printed in *The Iron Age*, the subject of heating greenhouses is treated historically, theoretically, and practically. The concluding portions of this paper contain good advice, and describe, in general terms, the merits of a system which, as its advantages become better known, seems destined to acquire a wide popularity. This advice, the soundness of which cannot be disputed, is that, in putting in hot water or steam apparatus for greenhouse heating, "there is no such phrase as '*good enough*' in the business; you must proceed carefully at all times with the pipe-tongs in one hand, the spirit-level in the other. Of course, an indifferent job of piping may work; were such not the case, I am afraid quite a number of our florists and private gardeners would have to call in the services of an expert. Where the piping is not put in properly, the circulation of the water or steam, if it circulates at all, will be sluggish, thus necessitating a greater force at the boiler, which means a greater expenditure of fuel than would be required under proper conditions. In all cases where a florist finds it necessary or advantageous to do his own piping, I should advise him to consult with the parties from whom he purchased the boiler, telling them plainly what he proposes doing, and ask them to furnish a plan of the work; this they will no doubt cheerfully do, for it is to their interest to have the work done well. With our modern boilers and systems of piping, the florist can regulate the temperature of various houses to suit the conditions required by different kinds of plants; the improvements in this direction are shown by the magnificent specimens exhibited at our flower shows. The use of 2-inch pipes, in conjunction with a proper arrangement of valves, gives us an opportunity for subdividing the heat such as was not possible with pipes of larger size."

The new system, which Mr. Burns calls the "combination overhead and underbench system," wherein the flow-pipes for hot water or steam are carried overhead, while the return-pipes are run back under the benches, presents the following advantages. (1) It can be adapted to the pressure system by placing a safety-valve on the expansion tank, or it can be used with an open tank, having no pressure but what is due to the column of water. (2) The heat is carried to the extreme end of the greenhouse in the shortest possible time, and, returning under the benches on either side, heats back to boiler from the extreme end, which can be kept at the same temperature as the end nearest the boiler. (3) It can be used on the up-hill or down-hill plan, to suit the grade of the greenhouse; this is very convenient when the house grades the wrong way. (4) An increase in the vertical height of the flow pipes is always followed by increased velocity, and therefore we get a quick circulation. (5) Last, but not least, should your greenhouse be situated in a place where you would strike water by digging down from 6 to 8 feet, or should you strike rock, this is the system that will help you out of your difficulty. I have carried out some work on this system where the base of the boiler was on a level with the heating pipes, and the water had to rise up to the return about 20 inches. We have a little boiler heating our office on this plan, where the main return-pipe travels about 50 feet along the floor, and about 18 inches below the return-pipe entering the boiler; after traveling 50 feet, this return-pipe drops under the floor about 10 inches, travels between two beams for about 17 feet, then rises up into the boiler; in both these cases the circulation is perfect. In greenhouse work I prefer to have a boiler pit at least 18 inches deep, so as to bring the return water back on a level. I have great faith in this system, for where I have used it the circulation has been very rapid, and the results more than I expected."

Popular Ideas of Ventilation.

THE crude notions popularly entertained upon the subject of ventilation are spoken of by a writer in *Heating and Ventilation* (Jan. 15) as standing in the way of progress in the art. These notions are not confined to ignorant people. Many fairly well educated persons remain who cannot understand that ventilation does not necessarily mean an open window, or a draft of wind, and who would fancy themselves ill-provided with pure air even in the best-ventilated rooms wherein these objectionable features were not certain evidence to eye and feeling that some pure outside air was entering. "The two ideas of wind and coolness form the whole of the public care or knowledge in regard to ventilation. There is also the incidental belief that foul air rises, and that there must be some means provided for letting it out. This idea takes concrete form in the little whirligigs seen in so many office-windows, and in the tendency towards opening windows at the top on 'general principles.'" The general belief and tradition is to make a hole somewhere in the upper part of the room, and then all foul odors, bad air, and other improper things in the atmosphere will quietly, and of their own accord and free will, let themselves out.

In these crude ideas we have practically all that the public knows or cares about ventilation. In the actual practice of the individual there is no intelligent appreciation of pure air, nor can most people tell whether the air they breathe is fit for respiration. Even people belonging to the educated classes do not use the evidence of their senses in regard to the quality of the air in their houses.

It is the duty of sanitary and ventilating engineers to educate the public up to a higher plane as regards ventilation; and, in order to do this, "there must be more general appreciation of the difference between pure air and foul air from their own characteristics rather than from circumstances which have nothing to do with the case." This means, of course, that attention must be given to methods for testing the quality of air in and of itself, without reference to visible means of supplying it, or to its sensible effects upon the surface of the human body. "When this educational work has been accomplished, the field of the engineer who devotes himself exclusively to ventilation will be the widest of any belonging to the engineering profession."

Location of Gas-Meters in Buildings.

THIS subject came up in a recent convention of the National Association of Fire Engineers in Montreal, and a paper read by Mr. Samuel Abbott, Jr., superintendent of the Boston Protective Department, appears in *Fire and Water* (Jan. 19). As related to the spread and control of fire, the location of gas-meters in dwellings is of much greater moment than most people would suppose. Experience has demonstrated the fact "that the maximum degree of heat from a fire first occurs at the highest point in a room (except in the immediate location of a fire), and, such being the case, it would be necessary to so locate the meter as to insure a minimum degree of heat for a reasonable time, thereby allowing for the discovery of the fire and notification of the fire-extinguishing forces before the heat had arrived at such a temperature as to melt the lead connections to the supply and distributing pipes or the soldering used in the construction of the meter. Very few fires originate in the immediate vicinity of a window in a building. Those that do are discovered early, and are invariably easily extinguished."

It is therefore recommended that meters should be located at points in buildings where the heat will be longest in reaching them; and this is always a point as low as is practicable. In ordinary city dwellings meters are placed mostly in cellars; but in the large tenement-houses and flats each floor has its separate meter, and sometimes there are several on each floor.

The main supply-pipe leading into a building should be easily accessible through a window, and should be supplied with a stop-cock, either in the sidewalk, or where it can be reached through a cellar window, so that, in case of fire, the gas may be readily and promptly shut off from the entire building. These precepts are enforced by citations of examples of fires rendered disastrous by escaping gas, and that could not be readily controlled for want of the precautions named. Meters should be placed on or near the floors of the rooms containing them, and not, as is too often the case, on shelves near the ceiling.

Heating by Furnaces.

WHILE steam and hot-water heating are very desirable for such as can afford these luxuries, the majority of people are and will be obliged to resort to furnaces for warming their buildings, and furnace heating may be made very good by proper care in proportioning the supply of heat and in erecting the plants. In *Domestic Engineering*, for January, Mr. G. D. Hoffman contributes an article upon furnace heating which considers it from a practical standpoint, which ignores entirely "cheap, poorly constructed furnaces" and deals with only such well constructed furnaces as do not leak gas, smoke, or dust from their combustion chambers. In his opinion the supplying of an abundance of fresh air by a properly set furnace more than offsets the evil of the accompanying dust. However this may be, it is a fact that very effective ventilation may be accomplished by the use of furnaces for heating, as this is a system of indirect heating, bringing the air from outside into the interior of the building warmed to a suitable temperature for the comfort of the occupants. One of the principal objections to furnace heating has been the overheating of the air introduced into buildings, not that this has been, as some have supposed, the cause of vitiating the air through the consumption of organic matter contained in it. This objection has been tested sufficiently to prove its invalidity. The trouble with the overheated air is that it is unpleasant to those who are obliged to be near the registers that admit it. It is better to have a large amount of air moderately heated than a smaller amount heated to a higher temperature. Mr. Hoffman points out that one of the hardest problems which presents itself for solution to the furnace man is to counteract the natural tendency for hot air to drift in the direction of the outside wide and thus cause the rooms on the windward side of the house to be cold, while the rooms on the other side are apt to be overheated. When furnaces are set in such manner that this action can take place (and it is very difficult to so set the furnaces that it can be obviated altogether) the building will be unequally heated and that side will be the colder which has the wind. In locations where the wind changes frequently, this renders uncertain the heating of the rooms, on any particular side of the building. The principle must be remembered that "air naturally flows in the direction of the least pressure and where there is the least resistance." The problem is to make the supply of cold air, acting through the cold air box, and pressing into the furnace chamber, gain sufficient force to overcome the resisting pressure of air in the rooms caused by the exterior winds.

Storm windows, ventilating flues, and independent controllable cold air ducts between rooms and furnace are the resources available to heating engineers for effecting this desirable result.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

27868. Improvements in Greenhouse Heating. Samuel Burns (Met W–Dec. 22.) 3800 w.

28414. Ventilation. George D. Hoffman (Met W–Jan. 12.) 2200 w.

28608. Proper Heating and Ventilating of School Buildings. Rufus R. Wade (H & V–Jan. 15.) 3500 w.

28610. The Popular Idea of Ventilation. Populi (H & V–Jan. 15.) 1500 w.

*28691. Furnace Heating. George D. Hoffmann (D E–Jan.) 1800 w.

28709. Determining Heating Power of Heating Systems. J. H. Kinealy (Met W–Jan. 26.) 1800 w.

28710. A Short Talk on the Construction of Hot Water Radiators. J. J. Wilson (Met W–Jan. 26.) 1300 w.

28711. The Heating and Ventilating Engineer—A Commercial View. Stewart A. Jellett (Met W–Jan. 26.) 1700 w.

28885. Steam-Heating Plant in the Hill Seminary. Ill. (E R–Feb. 2.) 1300 w.

28953. The Literature of Heating and Ventilating. Extracts. Hugh J. Barron (Met W–Feb. 2.) 1200 w.

28954. Heating and Ventilation of School Buildings. T. J. Waters (Met W–Feb. 2.) 3000 w.

*29055. Ventilators. Anon. (I C B–Jan. 25.) 1200 w.

29062. A Prison Heating and Ventilating Plant. Ill. Henry B. Prather (H & V–Feb. 1.) 2500 w.

Landscape Gardening.

28664. To Preserve the Palisades. Editorial (G & F–Jan. 23.) 1100 w.

Plumbing and Gas Fitting.

28557. Connecticut's Proposed Plumbing Law (Met W–Jan. 19.) 1800 w.

29127. Apprenticeship. (Abstract.) S. E. Dibble (Met W–Feb. 9.) 1200 w.

Miscellany.

†28408. The Economical and Efficient Disposal of the Household Garbage of New York. Thomas H. Manley and Douglas H. Stewart (San–Jan.) 2700 w.

Serials.

26907. Hot-Water Heating and Fitting. J. L. Saunders (H & V–Began Nov. 15—3 parts to date—15 cts. each).

27214. Combination Heating. Ill. J. W. Hughes (Met W–Began Dec. 1—3 parts to date—15 cts. each).

27783. Mechanical Heating and Ventilation. M. C. Huyett (I A–Began Aug.—6 parts to date—45 cts. each).

27848. The Names and Uses of Stops and Faucets. Ill. Calvin Fulton (S P–Began Dec. 15—3 parts to date—15 cts. each).

28431. Water Supply in the House of Mr. Cornelius Vanderbilt, New York City. Ill. (E R–Began Jan. 12—3 parts to date—15 cts. each).

28880. Heating Buildings — The Proper Rules to Use. Thomas Hawley (B J C–Began Feb. 2—1 part to date—15 cts).

29076. Installing Wood-Cased Bath Tubs. Ill. Grayson (S P–Began Feb. 1—1 part to date—15 cts).

29077. Practical Gas Fitting. Anon. (S P–Began Feb. 1—1 part to date—15 cts).

ELECTRICITY

A German Municipal Electric Station.

ONE of the finest examples of modern electrical engineering construction extant is that of Frankfort-on-the-Main, Germany, which is described in the *Electrical Engineer* (Jan. 9) by Dr. R. Haas. The plan of distribution adopted is that of the single-phase alternating current, but it appears that the determination to employ this was only arrived at after a very spirited controversy between the advocates of different systems, which occupied a number of years. The station, which commenced operations on October 12, 1894, has an ultimate capacity of 100,000 16-c. p. lamps. It is situated without the city on the bank of the river, at a point where coal and water are conveniently accessible. There are at present installed eight return tubular boilers with smoke-consuming furnaces. All the steam mains lead to a large drum, from which the engines draw their supply. Three engines are in position, and a fourth will soon be added. Each of these is a tandem compound, direct-coupled to a horizontal dynamo giving 500,000 watts at 3000 volts. The switchboard is located in a gallery, and is simple and convenient in design. Each dynamo has its separate complement of apparatus for control and regulation. The distributing system is entirely underground, and comprises high-tension feeders, high-tension mains, and low-tension mains. Six nodal points on the system of high-tension mains are fed by a corresponding number of feeders. Concentric asphalt-insulated cables are used, protected with an armor of iron ribbon. These are imbedded in sand in trenches about 3 ft. deep, and protected by a covering of brick, and, in some exposed places, of iron water-pipe. No connecting boxes are employed, the cables having been especially made in designated lengths, and thus a very high insulation is attained. The 3000-volt current is reduced to 110 volts by means of 90 transformers situated from 500 to 1000 ft. apart, which feed into a system of low-tension consumers' mains. The transformers are placed in pits under the sidewalks, which are lined with brick laid in cement. The transformer lies at the bottom submerged in oil; over this is a wooden floor covered with linoleum, and above this a space where the switches and safety devices are placed. The pit is closed with a ribbed cast-iron plate at the level of the sidewalk. Scale drawings of one of these pits are given, with details of the transformer-boxes. Moisture is carried off by a ventilating duct, the air circulation being effected by the heat given off by the transformer,—an arrangement which has proved highly satisfactory in practice. The distribution of current is excellent, the losses under maximum load being, in the feeders, 4 per cent.; in the high-tension mains, 1 per cent.; in the transformers, 4 per cent.; and in the low-tension mains, 1.2 per cent. The regulation is effected by the aid of pressure wires running back from the nodal points to the central station. The range of variation of pressure throughout the city seldom exceeds 1 per cent. in practice. The total cost—about $650,000—did not exceed the estimates, and the entire work was finished within six months from the time of its commencement.

The Edison Electric Company of Chicago.

THE *Electrical Engineer* (Jan. 23) devotes nearly twenty pages to an elaborate and well-illustrated article by T. C. Martin, descriptive of the works of the Chicago Edison Company. This company operates three distinct plants, but the main centre of interest, in a technical sense, is the great Harrison street station, which has been pronounced by capable critics by far the best example of advanced electric-light engineering to be found in the western hemisphere. The main engine and dynamo room of the station is well shown in a full-page photo-engraving of unusual excellence, and it certainly is a most impressive sight. The room is 209 × 62 ft. on the floor, and 60 ft. in height, faced with cream-colored pressed brick and lighted from the roof. The equipment comprises ten large vertical triple-expansion engines of varying dimensions, driving direct-coupled multipolar generators, the present aggregate capacity being 6400 k. w. or approximately 10,000 h. p., with the necessary complement of pumps, heaters, condensers, filters, etc. The station is operated on the Edison low-tension three-wire system, each engine being a three-wire unit in itself, inasmuch as it drives a pair of generators connected through switches to the three bus-bars on the switchboard. The conducting cables are made of 259 strands of No. 13 copper wire. The boiler-room has capacity to accommodate fourteen boilers, of which seven are now in use. The fuel used is residuum oil, brought by railway in tank cars. The daily consumption of oil is about 9000 gallons. The switchboard is of Italian marble, set in steel channel-beams. The regulating portion is composed of sixteen panels, each 20 in. wide, making a total of 26 ft. 8 in. Each panel is devoted to one unit, and has all the necessary appliances in the way of switches and testing and indicating instruments. The original station at Adams street, in the business centre of the city, is now used solely as a distributing station, being connected with the Harrison street station by enormous trunk-line feeders. This trunk-line is 3,340 ft. in length, and is carried under the Chicago river by a special tunnel 60 ft. below the street surface. The dimensions of the positive and negative grouped conductors of this trunk line are 21,000,000 circular mils each, and that of the neutral 3,000,000. There must therefore be something like 225 tons of copper in this trunk-line alone. The business of the company appears to be extensive and profitable. The number of incandescent lamps connected has increased from 17,812 in 1889 to 161,927 in 1894, and the motor service from 234 h. p. in 1889 to 4,210 h. p. in 1894. It is worth noting that the motor service has already reached 40 per cent. of the lighting capacity, and must be in operation at least twice as many hours per day. Many of the large office-buildings in Chicago buy their current from the Edison company, instead of running isolated plants. Some of these buildings are very large consumers; the Monadnock building, for instance, has some eight thousand lights. Altogether, the details of this gigantic plant, which are very fully given in the article, cannot but repay the most careful study on the part of those interested in the modern practice of electric distribution on a large scale.

Electric Competition with Steam Railroads.

NO small amount of space is being devoted in these days, in technical and other journals, to various aspects of the competition which is springing up in various localities between the newly-established electric street railroads and the long-established local and suburban service of the steam railroads. The *Electrical Engineer* (Jan. 6) discusses the matter editorially, with particular reference to the measures which some of the steam roads are adopting to retain their business where it is threatened with "trolley competition." It is to be regretted that the editor of the *Electrical Engineer* can discover no better motive for the disposition of the various State railroad commissioners and State legislatures to seek to put a stop to the reckless and totally unnecessary multiplication of grade-crossing death-traps than a purely selfish desire to protect the steam roads from electric competition; but nevertheless the writer expresses the opinion that "even this obstacle put in the way of competing trolley lines will avail nothing." Admitting this to be the case, there would seem to be nothing more to be said. The only argument against the total and absolute prohibition of the crossing of steam by electric roads that is worth a moment's consideration is that the increased cost of the separated grades will prevent the building of some trolley roads which would otherwise be built. As for the steam railroads, it is probably safe to assume that they will be able to take care of themselves. No doubt the new electric lines have in some places diverted a large amount of traffic from their older rivals, and caused the discontinuance, here and there, of a local train; but it is at least a question whether this loss has not been many times made up by new business brought to the steam lines from points not heretofore conveniently reached by existing modes of conveyance. As an example, who can doubt that the additional business brought to the Pennsylvania Railroad in such a city as Newark by the establishment of a vast system of converging trolley lines is not ten times as great as the amount diverted from it by the trolley lines which parallel it from Elizabeth to Jersey City? If the trolley lines can accommodate the travelling public better, or at lower fares than the steam railroads, they will get the business, and ought to have it. But if they cannot afford to do this without running at dangerous rates of speed along and across the public highways, and recklessly across grade-crossings, then the law should step in and check them. Millions of dollars have been spent by the principal railroad lines in this country within the past twenty years for the abolition of grade-crossings, and it is very much to be doubted if public opinion will permit this eminently necessary work to be stopped, and in some cases even undone, at the behest of the promoters of speculative electric street-railway enterprises.

How Incandescent Lamps Are Made.

ALTHOUGH fifteen years have passed since the first commercial introduction of the incandescent lamp, it is only within a few months that any adequate and intelligible account of the minute details of its manufacture has been published. Reference was made in this department a few months since to a somewhat elaborate article on this topic which appeared in journals devoted to the gas interest, and now we have, in the *Electrical Engineer* (Jan. 2), a detailed and well-illustrated account of the whole process of lamp-manufacture, as carried on in the extensive works of the General Electric Company at Harrison, N. J.,—the original establishment founded by Edison in 1882. Although the entire catalogue of material comprised in an incandescent lamp consists only of a glass bulb, a thread of carbon, two short pieces of copper wire and two of platinum wire, two shells of brass, and a little cement,—its only rivals in the realm of electricity in respect to simplicity being the magneto-telephone and the Morse sounder,—yet no less than forty-one different pairs of hands, exclusive of inspectors and carriers, are required to perform all the operations necessary to fit it for its destined work. Many of the processes are extremely delicate, and all are exceedingly interesting. It would take too much space to give even a bare outline of them here, so that those who are curious in the matter must be referred to the original article. It is a fact not generally known that the filaments of the best modern lamps are made of cellulose, as first proposed and practised by Weston, and that the carbon of fibrous structure so strongly insisted upon by the pioneers in the art of lamp-manufacture has become practically obsolete. The process of "flashing," or treating the filament in hydrocarbon medium while heated, originated by Sawyer and Man, has been adopted by this, as well as by all other successful manufactories. Some idea of the magnitude of the operations carried on at this factory may be gained from the statement that the present number of employees is 900, and that the aggregate output of lamps per day of 10 hours is no less than 28,000.

Modern Theories of Electricity.

IN the London *Electrician* (Jan. 18) Professor Oliver J. Lodge reviews at some length the article of Professor Rowland under the above title, which appeared in the January number of this magazine. Referring to Professor Rowland's explanation of the cause of terrestrial magnetism,—*viz.*, that the ether must be supposed to have such properties that the rotation in it of ordinary matter produces magnetism,—Professor Lodge says that this and other similar statements are full of "more than doubtful hypotheses"; that it has never been proved that magnetism is due to the rotation of something; that it is known that rotating electrification is a sufficient cause, but not necessarily rotating ether; and that against the proposition that the spinning of matter on its axis magnetizes it may be adduced many specially-directed experiments, all of which have given a negative result. "The alternative view championed by Dr. Larmer, that magnetism may be due to flow, and electric current to spin," says Professor Lodge, "has evidently not yet impressed him (Professor Rowland) as possessing any force or validity. It may be assumed as probable that he has strong reasons for this orthodox Maxwellian belief, and it would be interesting to know them. He considers magnetism more simple and easy to comprehend than electro-statics, which again must be considered as a thoroughly Maxwellian position; and it is interesting to see how the great foreign philosophers of the world are all slowly coming to recognize the magnitude of this great teacher. Professor Rowland, indeed, has long recognized it, and it is hard to speak of members of the Anglo-Saxon race as foreigners; but their aloofness from insular prejudice and the bonds of mother country renders their adhesion to the English, instead of to one of the many forms of continental theory, of special interest."

The Power Plant at Niagara.

THE *Electrical Engineer* (Jan. 16) gives some account of the present condition of affairs at Niagara Falls, accompanied with photographic half-tone views of the power-house, exterior and interior, and the 5000-h. p. two-phase generator which has just been installed, together with a sectional drawing of the latter. A description of this machine is given, somewhat in detail, and an interesting letter from Professor George Forbes to the London *Times*, descriptive of the work which has been done, is republished in full. In summing up, Professor Forbes says:

"The period of planning the transmission scheme, of designing the greatest dynamo in the world, and of construction of the first plant now closes. The financial period commences with the new year. The earning of dividends and the ordering of duplicate machinery is the future work of the company. In conclusion, it is difficult for me to say who were the boldest,—the capitalists who embarked on the scheme before any plans were matured, or the manufacturers who moved their factories to this field before a single result had been achieved. The action of both was typically American, but their confidence was not misplaced. Their success is now assured."

Another article on the same subject by Frank C. Perkins, with a number of additional illustrations, and further details of the progress of installation, appears in the *Electrical World* (Feb. 9).

The Electric Conductivity of Water.

MR. J. W. RODGER contributes to *Nature* (Nov. 8) an interesting *résumé* of the investigations which have been prosecuted within the past few years for the purpose of determining the electrical conductivity of pure water. Observations of this character have been rendered exceptionally difficult by reason of the impossibility of freeing the water from the last traces of dissolved impurity. According to the latest determinations, one millimeter of water has at 0° almost the same resistance as 40,000,000 kilometers of copper wire of the same cross-section. It has been suspected that absolutely pure water might turn out to be a non-conductor. But Kolrausch and Heydwiller, by means of the hypotheses involved in the new theory of solutions, have shown that it must be a conductor, and they fix its probable conductivity at 18° at 0.0043 of that of mercury, which is taken at 10^{10}, the accepted figure prior to 1875.

Storage-Battery Manufacture.

THE storage battery has long been an important factor in the economical production and distribution of currents from central stations in all European countries, but for various reasons, some of which have heretofore been adverted to in this department, it has never met with much favor among central-station managers in this country. But indications are not wanting that in this respect matters will soon assume an entirely different phase. The controlling patents and the most prominent business interests in this field in the United States have recently been united in a single organization, and the manufacture has been commenced in Philadelphia on a large scale. In the *Electrical Engineer* (Dec. 10) an excellent article is given, in which the whole process of manufacture of the chlorid accumulator is minutely described, numerous illustrations of the plant and processes reproduced from photographs accompanying the text.

Long-Distance Telephony.

COMPARATIVELY few persons, even among those well versed in electrical matters, have any adequate conception of the amount of study, investigation, and experiment which has been necessary to bring the development of long-distance telephony to its present state of perfection. The present condition of the art is briefly but intelligibly summed up in an article by F. W. Dunbar in the *Electrical World* (Jan. 12). Diagrams are given of the arrangements of the circuits on a long-distance line, and also of an apparatus now in practical use by which the same wire may be used simultaneously for both telegraphic and telephonic service without the slightest mutual interference. This is done by inserting condensers in the telegraphic branches at each end, which freely permit telephonic vibrations to pass, but are impervious to the steady currents used in telegraphy, while, on the other hand, the telephonic instruments are screened from the effects of sudden changes of current at the beginning and end of each elementary telegraphic signal by means of "retardation coils." By a singular mistake the cuts representing the two systems have been transposed by the printer,—which may possibly cause some confusion in the minds of persons unfamiliar with the general subject.

Modern Underground Cables.

IN the *Electrical World* (Jan. 19) William Maver, Jr., has a paper giving a concise, but very complete and intelligible, account of the modern methods of manufacturing, testing, and installing underground electric cables,—an art which, in its present aspect, has practically been developed within the past ten years. The article is well illustrated with perspective views and diagrams showing the various machines and processes employed. Among the most effective illustrations are two arranged on the "deadly parallel" plan, showing a section of lower Broadway before and after the compulsory removal of the overhead electric lines in New York city. Surprise is sometimes manifested that it should be possible to replace the vast and intricate mass of overhead wires which formerly darkened the streets of the metropolis by a comparatively small number of subterranean ducts. The explanation is very simple, and is found in the fact that one hundred wires, which make a heavy burden for a pole line, can be stowed away in a single cable in a three-inch subway duct. One of the most curious facts in connection with this subject is the increasing use of paper as an insulator. Under proper conditions it is found to answer most purposes admirably, while its indestructibility and cheapness are important points in its favor.

A Municipal Electric Light Plant.

IT is a circumstance worthy of remark that, while there are already a considerable number of municipal electric lighting plants in operation in various parts of the country, nearly all of them are located in places where a private company could not have profitably undertaken to do the business. Now and then, however, we come across one of these small municipal plants which is exceptionally well managed and shows very satisfactory results. One of these, that at South Norwalk, Conn., forms the subject of an article in the *Electrical Engineer* (January 30). It is a street-lighting plant of 120 2000-c. p. arc-lamps, supplied by two dynamos of 60 lights each, driven by a 100-h. p. high-speed engine. The fuel used is a mixture of two parts bituminous coal and one part locomotive sparks, bought in car-loads from a railway company. The station is of brick with a slated roof, 40 by 66 feet, and capable of convenient enlargement if required in future. The average number of nights lighted per year is 309; the average cost of lighting per lamp per year, including interest and depreciation, $59.29; pounds of coal per light per night, 23.29. The operating force consists of a superintendent, an engineer, and a lineman, who are appointed by Electric Light Commissioners elected by the people for terms of three years. In the *Electrical Engineer* of February 6, Mr. A. E. Winchester, one of the Board of Electric Light Commissioners for the current year, publishes a communication, in which he states that he is no advocate of municipal electric-light plants, or of other municipal business institutions, except under the most favorable conditions, which, he is careful to add, "are seldom met with except in theory." He further states that which, to be sure, is already pretty well known,—that "the primary reason for this increase in municipal plants is largely due to schemers, who by glowing promises make a business of obtaining valuable franchises from progressive little cities, and in return establish a cheaply constructed plant with the expectation of unloading the stock at a handsome profit upon the citizens." If the citizens do not "bite," the non-residents who own the plant usually seek to curtail the cost of operation at the expense of good service, and meanwhile the protests of the consumers are unheeded by the owners, who believe themselves protected by their charter in a monopoly of the business. It is then, as a last resort, that the people begin to talk of a municipal plant. The establishment of the South Norwalk plant appears to have been due to some such condition of affairs as that above referred to. "The great enemies of municipal plants"—says Mr. Winchester—"are politics and partisanship." Exactly so, and politics and partisanship in American towns and cities are the rule, while the exceptions are few and far between. It is gratifying to be assured that the management of the South Norwalk plant is non-political; for the sake of the citizens who are served by it, it is to be hoped that it may long remain so.

In this department last month was given an abstract of a published description of the electric-railway system of the Philadelphia Traction Company. In the *Electrical Engineer* (Jan. 9) appears an excellent illustrated account of another system in the same city,—*viz.*, the Hestonville, Mantua, and Fairmount Passenger Railway Company. The Philadelphians were slow in taking up electric railroading, but it would certainly seem that the delay which has enabled them to profit so largely by the experiences, fortunate and otherwise, of other people has not been without its compensations. Many of the details of the construction of this road are of much interest.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review Other abbreviations are, Ill=Illustrated; W=Words.

Lighting.

*28454. The Light of the Future. John Gray (E R L–Jan. 4.) 1800 w.

*28492. Electric Energy for Town Lighting. Walter J. May (Inv–Jan. 5.) 700 w.

*28597. The Electricity Works at Yarmouth. Ill. (E E L–Jan. 11.) 5200 w.

*28626. Higher Voltage Lamps for Central Stations. G. L. Addenbrooke (E R L–Jan. 11.) 2400 w.

28680. The Frankfort-on-the-Main Municipal Light and Power Plant. Ill. G. J. Melms. (E W–Jan. 26.) 3000 w.

28706. Incandescent Lighting on the Meter System Compared with the Contract System. G. L. Cole (W E–Jan. 26.) 800 w.

28720. On the Degree of Incandescence of Lamps. M. A. Crova (E A–Jan. 26.) 1100 w.

28809. Incandescent Lamp versus Welsbach Burner. William Goetz (E R N Y–Jan. 30.) 2000 w.

28812. On the Units of Light and Radiation. A. MacFarlane. Read before the A. I. E. E. (E N Y–Jan. 30.) 1900 w.

28961. Interior Conduit and Interior Wiring. Charles E Burton (W E–Feb. 2.) 3000 w.

28989. Electric Car Lighting System on the New York and Brooklyn Bridge Railway. Ill. (S R G–Feb. 2.) 800 w.

29064. The Fredureau Light-Diffusing Globe. Ill. Abstract by V. M. Berthold of a paper read before the French Academy (E R N Y–Feb. 6.) 550 w.

29095. Electric Lighting for Carriages. C. W. Chancellor (W E–Feb. 9.) 1000 w.

29119. Electric Lighting in Mexico—The Plant of the Aquas Calientes Electric Light Company. Ill. George Heli Guy (E E N Y–Feb. 6.) 1600 w.

Power.

*28377. Electric Power in Southern Cotton Mills. A. F. McKissick (E Mag–March.) 2500 w.

28443. The Lake Simcoe Power Aqueduct. E. A. MacDonald (C Eng–Jan.) 1500 w.

*28455. Possible Improvements in the Supply of Electrical Energy. S. Z. de Ferranti (E R L–Jan. 4.) 1500 w.

28523. Niagara To-day. Ill. (E E N Y–Jan. 16.) 1200 w.

28535. Constant Speed Motors. Thomas J. Fay (E A–Jan. 19.) 1200 w.

28594. The Warden Power Building, Philadelphia, Pa. Ill. (E R–Jan. 19.) 2200 w.

*28598. Electrical Energy—What It Is! R. C. Shettle (E E L–Jan. 11.) 1000 w.

*28629. The First Polyphase Motor. Ill. S. P. Thompson (El–Jan. 11.) 500 w.

28705. The Chicago Edison Company—Its History and Its Work. Ill. T. C. Martin (E E N Y–Jan. 23.) 6000 w.

*28768. Design and Efficiency of Plant for the Transmission of Power by Electricity. W. C. Mountain (I & I–Jan. 18.) 2000 w.

28906. A Test of a 65-H. P. Motor. Thomas J. Fay (E A–Feb. 2.) 1100 w.

28909. The Eddy Street Power Station at Providence, R. I. Ill. George T. Hanchett (E W–Feb. 2.) 1400 w.

28958. Electrical Power in a Large Newspaper Establishment—The Philadelphia Inquirer. Ill. (W E–Feb. 2.) 900 w.

28959. Some Characteristics and Economies of Accumulators as Applied to Central Lighting and Power Stations. Ill. John R. Markle (W E–Feb. 2.) 1900 w.

28960. Hints Upon Daily Work About a Dynamo Plant. Pliny Norcross (W E–Feb. 2.) 3000 w.

29067. The Niagara Power Transmission Plant. Ill. Frank C. Perkins (E W–Feb. 9.) 3000 w.

29121. A Dynamo Safety Device for Abnormal Potential. Ill. Device of Messrs. C. T. Penton, C. C. Gartland and P. J. Casserly (E E N Y–Feb. 6.) 450 w.

Telephony and Telegraphy.

†28388. The Evolution of a Switchboard. Ill. Arthur Vaughan Abbott (B U W–Vol. I, No. 4.) 9000 w.

28394. Signing One's Name a Hundred Miles Away—Signatures that Will Be Recognized by the Banks—Are they Autographs? The Telautograph. Nelson W. Perry (E N Y–Jan. 9.) 1800 w.

28425. Paris-London Telautograph Test (W E–Jan. 12.) 600 w.

28475. Long Distance Telephony. Ill. F. W. Dunbar (E W–Jan. 12.) 2000 w.

28524. The Postal Telegraph Company in the West. George Heli Guy (E E N Y–Jan. 16.) 1100 w.

28527. Transmitting, Recording and Seeing Pictures by Electricity. Ill. George R. Carey (E E N Y–Jan. 16.) 1000 w.

28531. The Telephone.—An Explanation of Its Modus Operandi.—The Musical and Speaking Telephones and their Essential Differences Described. Nelson W. Perry (E N Y–Jan. 16.) 2500 w.

28560. The Importance of the Fire Alarm Telegraph System. F. C. Stoves (F W–Jan. 19.) 1700 w.

28648. The Magneto Telephone.—Plain Directions How to Construct, at Small Expense, a Most Serviceable Instrument for the Residence or Office. Ill. Nelson W. Perry (E N Y–Jan. 23.) 2500 w.

28653. Means for the Removal of Electrode Surface in Telephony. Ill. Telephonist (E R N Y–Jan. 23.) 800 w.

28668. The New Telephone System in Paris. Ill. E. Hospitalier in La Nature (Sc A–Jan. 26.) 2700 w.

28879. Printing by Telegraph (B J C–Feb. 2.) 900 w.

28942. The Mexican Central Railway Telegraph System. George Heli Guy (E E N Y–Jan. 30.) 900 w.

*28997. The Origin and Development of the Telephone Switchboard. J. E. Kingsbury (E E L–Jan. 25.) 8000 w.

29058. The Microphone or Battery Telephone Transmitter.—The Footfalls of a Fly Made Audible to Human Ears.—The Great Service Rendered to Science by this Simple Invention. Ill. Nelson W. Perry (E N Y–Feb. 6.) 2500 w.

Miscellany.

*28374. Electric Wiring and the Fire Hazard. F. E. Cabot (E Mag–March.) 3000 w.

28395. The Legal Status of Electrical Wires in the Streets. R. D. Fisher (E N Y–Jan. 9.) 1400 w.

*28396. An Electric Shock, by Lesser Columbus.—Descriptive of the House of Siemens. Ill. (Com–Dec. 26.) 16000 w.

*28450. The Future of Electricity. Sidney F. Walker (E E L–Jan. 4.) 1800 w.

*28453. High Pressure v. Low Pressure. Rankin Kennedy (E R L–Jan. 4.) 1600 w.

*28463. Electrical Engineering. Editorial (Eng L–Jan. 4.) 3300 w.

*28473. A Determination of the Specific Heat of Water in Terms of the International

Electric Units. Arthur Schuster and William Gannon (El-Jan. 4.) 1300 w.

28526. How Does Electricity Kill? E. B. Rosa (E E N Y-Jan. 16.) 1500 w.

28528. The Electro-Chemical Actinometer.—Its Discovery and Practical Uses. Prepared by V. M. Berthold from M. Ch. Marechal's Paper (E R N Y-Jan. 16.) 2800 w.

28546. The Making and Laying of Underground Cables. Ill. William Maver, Jr. (E W-Jan. 19.) 5500 w.

28558. Thomson-Houston Regulator Patent Declared Void.—Judge Grosscup's Decision (W E-Jan. 19.) 2000 w.

*28622. On the Electrical Resistances of Certain Poor Conductors. B. O. Peirce (E R L-Jan. 11.) 1800 w.

*28623. Local Action in Accumulators. G. Darriens (E R L-Jan. 11.) 1700 w.

*28627. On the Properties of Batteries Formed of Cells Joined Up in Multiple Arc. B. O. Peirce (E R L-Jan. 11.) 1000 w.

*28628. Is the Magnetic Quality of Iron Affected by Often Repeated Reversals? Professor Ewing (El-Jan. 11.) 800 w.

*28640. The World's Debt to Electricity. John Trowbridge (Ch-Feb.) 2500 w.

28654. The Best Metal for Field Magnet Frames. Alton D. Adams (E R N Y-Jan. 23.) 700 w.

28673. Electric Accumulators Under Pressure.—Messrs. Cailletet and Colardeau's Apparatus. Ill. (Sc A S-Jan. 26.) 1400 w.

28682. Electrical Medical Apparatus. Ill. Harry F. Waite (E W-Jan. 26.) 400 w.

*28737. The Walker-Wilkins Voltaic Battery. Ill. (E R L-Jan. 18.) 1200 w.

*28756. On the Retardation of Polarization in Dielectrics. Riccardo Arno (El-Jan. 18.) 800 w.

*28758. Professor Rowland on Modern Theories of Electricity. Oliver Lodge (El-Jan. 18.) 1800 w.

*28771. Inaugural Address of R. E. Crompton before the Meeting of Electrical Engineers (E E L-Jan. 18.) 9500 w.

28810. A Few Words on "Carrying Capacity" of Conductors. J. E. Talbot (E R N Y-Jan. 30.) 1000 w.

28944. Alternating Currents. E. J. Houston and A. E. Kennelly (E E N Y-Jan. 30.) 900 w.

*28972. Modern Electricity. Editorial (Eng-L-Jan. 25.) 2500 w.

*29044. Electrical Engineering in 1894 (E Rev-Jan. 21.) 1500 w.

29066. Electrical Difference of Potential. William A. Anthony (E W-Feb. 9.) 800 w.

29068. Electrical Consonance. M I. Pupin (E W-Feb. 9.) 1800 w.

29069. How to Build a Rheostat—For Amateurs. Ill. G. E. Dunton (E W-Feb. 9.) 1000 w.

29070. Dry Batteries. L. K. Böhm (E W-Feb. 9.) 1200 w.

†29079. Discussion of Ludwig Gutmann's Paper—"The Production of Rotary Magnetic Fields by a Single Alternating Current" (T A I E E-Jan.) 5000 w.

Serials

22059. Practical Notes on Dynamo Calculation. Ill. Alfred E. Wiener (E W-Began May 19—28 parts to date—15 cts. each).

22131. The Incandescence Lamp. A. Bainville (E R L-Began May 11—8 parts to date—30 cts. each).

23866. Electrodynamic Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W-Began July 21—25 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Ill. Newton Harrison (E A-Began Aug. 25—20 parts to date—15 cts. each).

25095. Postal Telegraphs. Ill. James Bell (E L-Began Sept. 7—21 parts to date—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y-Began Sept. 19—17 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (E L-Began Oct. 5—17 parts to date—30 cts. each).

25907. The Alternating Current; Its Generation and Distribution. Ill. George D. Shepardson (E I-Began Oct.—4 parts to date—15 cts. each).

26592. Electrical Power Transmission. Louis Bell (E W-Began Nov. 10—12 parts to date—15 cts. each).

27371. The Electric Light. Ill. Henry Stooke (I C B-Began Nov. 23—10 parts to date—30 cts. each).

27506. Suggestions in Preparing Specifications for the Electric Lighting of Buildings. Nelson W. Perry (E R-Began Dec. 8—3 parts to date—15 cts. each).

27704. Some Hints on the Building of Electric Plants. Charles G. Armstrong (E I-Began Dec.—2 parts to date—15 cts. each).

27855. Methods of Determining the Efciency of Dynamos and Motors. Ill. J. Reginald Ashworth (E P-Began Dec.—2 parts to date—30 cts. each).

28624. The Testing and Inspection of Electric Light Cables. Anon. (E R L-Began Jan. 11—Ended Jan. 25—2 parts—30 cts. each),

28759. The Electric Arc. Ill. Hertha Ayrton (El-Began Jan. 18—2 parts to date—30 cts. each).

28811. The Distribution of Energy in the Spectrum of the Glow Lamp. Edward L. Nichols (E N Y-Began Jan. 30—2 parts to date—15 cts. each).

29041. The Recent Growth of Electrical Engineering. S. Flood Page (E Rev-Began Jan. 21—1 part to date—30 cts).

29132. Magnetic Mechanism. Ill. Wilbur M. Stine (E A-Began Feb. 9—1 part to date—15 cts).

INDUSTRIAL SOCIOLOGY

The Independent Labor Party.

Of the recent movements that have their origin in the restless spirit now pervading the laboring classes, the formation in England and Scotland of the Independent Labor Party, its successful attempt to effect an efficient organization, and its rapid growth in numbers and influence, are among the most significant. This party is unconnected with either Liberalism or Toryism. It effected its present organization in 1893, and its existence may be taken as dating from a conference held at Bradford in that year, at which one hundred and twenty delegates from different parts of the kingdom were present. This convention seems likely to become historic. Mr. J. Keir Hardie, M. P., in the *Nineteenth Century* for January, has presented a full account of the origin, growth, organization, and political creed of this new party.

Prior to 1893 fitful and unfruitful efforts to establish a party had only resulted in multiplying candidates who received small support at the elections. There were quite a number of so-called "Independent Labor Organizations," but each acted by itself, and there was no plan for securing concerted action. The Bradford convention in 1893 brought all these associations into a single organization, which, together with accessions to its numbers since that meeting, now numbers over fifty thousand.

"A second conference was subsequently held in Manchester in February, 1894, at which none but representatives from branches which had affiliated to the Independent Labor Party were admitted. Ninety-four delegates attended, some representing several branches. Again the conference sat for two days, and the programme agreed to at Bradford was slightly amended. Since then the movement has gone on developing by leaps and bounds, and in a directory just issued by the secretary, Mr. Tom Mann, a full list of branches in all parts of the country is given. In Lancashire and Cheshire there are 68 branches; in Yorkshire alone, 101; Scotland is represented by 40; London has 30; the Midlands, 21; North-eastern counties, 15. There are several branches in Wales and 2 in Ireland. The total number of branches presently existing is over 300, comprising a total membership of over 50,000."

Each member pays a minimum of 1 penny per week as his contribution to the treasury of the organization, but the average is 3 pence per week, which results in a yearly collection of £32,500. Aside from this, liberal sums have been specially contributed for election expenses by members and friends of candidates. "Many working-men, earning not more than 25 or 30 shillings per week, have contributed from 10 to 20 shillings toward these bye-election funds."

The voting strength of the party is said to much exceed its financial membership. And as an example of this, the case of Mid-Lanark in the April election is cited. Here, with a membership of 100 candidates, the party received 1221 votes. In Leicester, where, previous to the election, no branch had been organized, the Independent Labor Party candidate received 4402 votes.

"The organization of the party proceeds on the following lines: in each constituency one branch is recognized, which, however, may be divided into ward or parish sections for the purposes of organization. These branches are affiliated to 'county federations,' or, in the case of boroughs, into 'councils'; such councils and federations supervising the work over the entire area covered by the branches represented thereon. A conference is held yearly of one representative from each branch. This conference is the supreme authority for the whole organization. Its decisions are binding alike upon branches and members. From this annual conference president, secretary, treasurer, and a committee f six are selected. These form what is nown as the 'National Administrative ouncil,' which continues in office until he next conference is held. This council s purely administrative and may not iniiate any new policy without the sanction f the conference. In addition to carrying ut the decisions of the conference at hich it was appointed, the council is exected to raise funds for the general work f the party, and a special election fund to id branches running candidates."

The object of this organization is formuated as, "the collective ownership and ontrol of the means of production, disribution, and exchange"; and the methods y which the object is to be attained are independent representation of the people n the house of commons and in all legisative, governing, and administrative bodes, and by propaganda by means of literaure and public meetings."

The conditions to which a candidate nust subscribe before the new party will ccord him its favor and financial support re: "(1) that he will advocate the object nd programme of the Independent Labor Party; (2) that, if returned to parliament, e will form one of the Independent Labor Party there, and sit in opposition, without egard to the political color of the party n power; (3) that he will act with the najority of the Independent Labor Party n the house of commons, irrespective of he convenience of all other political paries. In selecting candidates, each branch nust obtain the consent of the national dministrative council of the party before heir candidate can be recognized."

Law of Corporations.

To Judge Gaynor, of Brooklyn, N. Y., not nly the State of New York, but the whole ountry, is indebted for the firm, wise, and quitable stand he has taken on important ssues, and his calm, unbiased, impartial adninistration of justice since he has been on he bench. His recent decision in the natter of the application of a private citien for a mandamus to compel the Brookyn Heights Company to run its cars, which vas one of the most important incidents of he great strike of the employees on the electric street railways of that city, will do much toward relieving the traveling public from the embarrassments accompanying such strikes, while, at the same time, it wrests from corporations one of the most powerful weapons by which they have hitherto resisted the demands of employees.

In the case of the Brooklyn strike there can be no question that the men asked for nothing unreasonable or unjust. That their demands were resisted so long by some of the corporations was due to the fact that these corporations illegally suspended the operation of their roads, to the great inconvenience of the public, and to the serious injury of business, both in Brooklyn and New York. What Judge Gaynor says in his decision of the Brooklyn Heights Company applies equally to all railway corporations. Their first duty, he says, is to the public, and not to their stockholders. The following extract from the decision, as printed in the New York *World* (Jan. 25), very clearly states the relations of these corporations to the public:

"It is my duty to declare the law of this case. This railroad corporation is not in the position of a mere private individual or company carrying on business for private gain, which may suspend business temporarily or permanently at pleasure. On the contrary, it has a dual relation,—a public relation to the people of the State and a private one to the stockholders.

"It must not be forgotten here, though it may seem to be growing dim, if not wholly forgotten elsewhere, that in its chief aspect it is a public corporation, having duties to perform to the public which transcend any obligation which in its private aspect it owes to its stockholders. It has received franchises of great value from the State, and had conferred on it the State's transcendent power of eminent domain. In return it took upon itself the performances of public duties and functions, in the performance of which it is in law and in fact not an independent individual or entity, but the accountable agent of the State.

"Though these principles are old and inherent in the idea of the sovereignty of the people, it would seem that in the recent rapid growth of corporate power, and of the tendency to use public franchises for the aggrandizement of individuals first, and for the service and benefit of the public second, they have come to be somewhat overlooked, and need to be restated. They have often been declared by the higher courts of this State and the Supreme Court of the United States (Olcott vs. the Supervisors, No. 16 Wall, 687, 694; Bloodgood vs. Mohawk, &c., R. Co., 19 Wend., 9; The People vs. N. Y. C. and H. RR. Co., Hun., 543). The duty of the company now before the court is to carry passengers through certain streets of Brooklyn, and to furnish, man, and run cars enough to fully accommodate the public. It may not lawfully cease to perform that duty for even one hour.

"The directors of a private business company may, actuated by private greed, or motives of private gain, stop business and refuse to employ labor at all unless labor comes down to their conditions, however distressing, for such are the existing legal, industrial, and social conditions. But the directors of a railroad corporation may not do the like. They are not merely accountable to stockholders; they are accountable to the public first and to their stockholders second. They have duties to the public to perform, and they must perform them.

"If they cannot get labor to perform such duties at what they offer to pay, then they must pay more, and as much as is necessary to get it. Likewise, if the conditions in respect of hours or otherwise which they impose repel labor, they must adopt more lenient or just conditions. They may not stop their cars for one hour, much less one week or one year, and thereby beat or coerce the price or conditions of labor down to the price or conditions they offer.

"In respect to the question of hours and wages between the company and its employees, its duty was to have gone on, and it is to go on with its full complement of employees, having the right gradually and from day to day to supersede its employees, if it can, by new employees who will work on its terms, or to supersede them all at once when it has obtained a sufficient number of new employees for that purpose; but in such a controversy it has not the right to stop its cars while it is thus gradually getting other men.

"If the people of the State were running these roads, they would not thus incommode and damage themselves, and it must not be forgotten that this corporation is intrusted with the running of these roads as the servant of the people of the State.

"It therefore only remains for me to determine the form of the writ."

The New York *World*, Brooklyn *Eagle*, and other papers, commenting editorially upon this decision did not dispute its legal accuracy, but asserted that the Brooklyn roads were not able to run their cars as a matter of fact, and that neither corporations nor individuals can be legally forced to do impossibilities. But the fact is that, if their employees had been justly treated, there would have been no interruption of traffic, and at any time the strike would have terminated by conceding to these men what they demanded. There was no impossibility in this. What the companies did was to run some cars under difficulties, and let the public wait for what Judge Gaynor states should have been constantly supplied. No one believes that the entire force of striking employees on the Brooklyn roads could have been replaced in one hour, or one week, even if there had been no violent opposition to such an attempt. The real impossibility was in getting new men, but, according to the decision, this was no excuse for the failure of the companies to run their cars. However, Judge Gaynor, doubtless glad of the opportunity to shift the responsibility this interpretation of the law entailed, availed himself of a technicality, and on a question of fact raised by the Brooklyn Heights Company, allowed it twenty days to show cause why a peremptory mandamus should not issue.

Migration of Population.

THE tendency in the discussion of labor disturbances to single out some one social tendency and to set this up as the controlling factor is one of the peculiarities of the current debate kept up by magazine writers upon the "burning question." Thus Mr. Geoffrey Drage, in the *Fortnightly Review* for January, under the title "Alien Immigration," assumes, or, rather, asserts, that "experience points to the inevitable acceptance of the migration of population as a determining factor in the labor question," and maintains that it points also to the desirability of leaving that migration as free from artificial stimulus as from arbitrary limitations. Therefore the logical conclusion must be that, if migration be not meddled with, either in the way of help or hindrance, it will of itself work out the solution of the problems that now perplex the industrial world. If migration be "the determining factor" and its influence be not interfered with, it will certainly determine the future of industry. All we have to do then is to wait and endure present ills, until migration has done its perfect work. How long we shall probably have to wait and suffer is not intimated by Mr. Drage. From all that can be gathered it appears to be a very slow process indeed, and meanwhile the content of the laboring classes does not increase. On the contrary, discontent grows and threatens. But, although this shifting of population is the grand panacea for social ills, and although it must not be stimulated or obstructed, but left perfectly free to operate in its own way, it is admittedly not "a matter of indifference to the governments of Europe or of any other continent. On the contrary, it is clear that outside England it calls for the most urgent attention, whether the question at issue be the European movement from east to west, or whether it be the tendency of the yellow races to spread themselves eastwards over the shores of the Pacific or southwards through Malaysia into Australia. These two great movements of the European and Mongolian peoples, together with the immense migration from India to the Crown Colonies and to Africa, and the spread of the black races in America, constitute in its broad outlines the population question, and therefore the labor question of the future. In Europe the Latin races of the South and the great Slavonic peoples of the East are gradually pressing the Teutons within narrower and narrower limits. Italy has, indeed, recently made some attempt at internal colonization, but the Italians still come in their thousands into Austria, just as they pass northwards into Switzerland. The Russian government may desire an expansion into Siberia, but the great massing of the Slavonic peoples is upon the Teutonic frontiers; they are expanding, as the peoples of Eastern Europe have always expanded, westwards, whilst the peoples of Western Europe emigrate wholesale to America. The vast emigration from Scandinavia is making room for a Slavonic advance, slower certainly than the advance further south, owing to difficulties of climate, but still taking its share in the gradual supplanting of Teutonic labor and Teutonic civilization." In conclusion, it is claimed that alien immigration into England scarcely deserves to be compared with that received by other countries, and that England is happily free from the problems which beset its continental neighbors and from "the pressing industrial competition which American workmen allege as a reason for demanding protection"; but it does not clearly appear that Mr. Drage has succeeded in establishhis thesis that the solution of the labor question is to be worked out by the migration of population, and that this should be left entirely free from interference.

The Industrial Situation.

WHAT is the matter with the commerce of the world? Everyone is seeking to answer this question, and numerous causes are assigned, each of which is regarded by the person offering it as ample to account for the present status. The year 1895 begins under most peculiar conditions. Abundant wealth and abundant poverty exist, with apparently no commercially practicable way open whereby capital can be so used for the benefit of labor as to relieve either of its present idle surplus. The idle surplus both of capital and labor is the problem which now confronts the nations. In an editorial, *The Engineer* (London, Jan. 4) takes a common view of the situation, but, as usual in articles of this sort, fails to grasp the question in its entirety. The fault is considered to be all on the side of labor. If labor would concede to capital all that the latter requires, the difficulty would be ended. Labor can get all the employment it desires, if it will accept it on the terms offered by capital.

"There is in this country—and, we may add, in the United States—a great mass of capital seeking employment, and for two principal reasons this capital will not be used. The first is that engineers appear to be unable or unwilling to suggest an outlet for it; the second, and by far the more important, is that capitalists have no confidence whatever in the common sense and ability of labor leaders. The capitalist regards the labor leader as a mischievous windbag. Now, as a rule, the capitalist is a very shrewd man of business; if he were not, he would not be a capitalist. He likes to coöperate with sensible men, and he abhors dealing with fools. Up to the present no labor leader has started on commercial lines; not one has shown that he possesses the knowledge, the mental stamina, or the influence requisite. Suppose that to-morrow such a man came forward, and proved that he could lead and control five thousand or ten thousand men, and that he could place them, on terms to be rigidly carried out, at the disposal of a syndicate of capitalists; is it to be imagined that the money would be lacking to carry out a great enterprise? Not for a moment. The truth is, if the labor leaders could only see it, that they can have all the capitalists in the kingdom working eagerly with them, if they will give them a chance. But this is just what the labor leaders will not do, because they permit sentiment, and fancied wrongs, and wild notions manufactured in Poland, Hungary, Italy, Russia—countries which have nothing in common with Great Britain—to usurp the seat of common sense. If only they could once see that the reason why a man becomes a capitalist is that he flings such ideas to the winds, and deals with the world as it is and not as it ought to be, and, taking a lesson from him, would understand that such things as strikes on a falling market are blunders, and that labor can have the use of any amount of capital it thinks proper to enjoy if only it will go the right way to work, then would a new era open, and trade would once more advance by leaps and bounds."

It is pointed out that the efforts of labor to improve its condition by the method of strikes in 1894, have almost all been failures. "Strike after strike has collapsed because they were started without any knowledge of the prevailing conditions of trade." While this may be admitted as a strong argument against the wisdom of the method of strikes, it cannot be accepted as proof that labor-leaders are "fools," that labor suffers only "fancied wrongs," that its notions are all "wild notions manufactured in Poland, Hungary, Italy, Russia," or that "sentiment" should find no place in the adjustment of existing issues. So long as the scope of sentiment, which is the basis of all charity (it might also be said to be the basis of ethics), is confined to public and private effort for the relief of want, just so long will the present strained relations between capital and labor continue and increase. It is this mischievous principle—that feeling has no place in business—which is working out the evil tendencies of the age. A man is not a mere machine without feeling. This cult of supreme selfishness has already wrought enough woe in the world. It is time that in business, as well as in private intercourse, some regard to the welfare of others should be considered essential to that morality which can command public approval.

The Future of American Shipping.

THE disabilities under which the shipping interests of the United States at present labor, and the proposed remedy,—discriminating duties,—are discussed by Mr. Richard P. Joy, in *Seaboard* (Dec. 13). The present Democratic congress is charged with "retrogression instead of progression," and the president is styled a "superficial observer" in consequence of his speech at the launching of the *St. Louis* at Philadelphia a few weeks ago, wherein he favored the free-ship bill, and wherein he asserted that the *St. Louis* was the result of the relaxation of our present registry laws. Mr. Joy asserts that "the owners of those ships would never have asked congress for an American registry had it not been for this act. It was a special case, and one which should not be repeated, for it was the entering wedge for free ships, and a dangerous precedent. Should congress pass a free-ship bill, would it help our marine? Could Americans operate against the low wages paid foreign seamen, and against the heavy bounties, mail subsidies, and subventions which foreign governments have granted their shipping? American shipowners have told me that they cannot, and, that no matter where a ship is built, it is folly for them to engage in any trade but the protected coastwise trade. If congress should pass the free-ship bill, as Mr. Cleveland advises, it would strike a savage blow at the American coastwise trade, for congress cannot dictate what trade a ship under the American flag shall enter."

It is plain that the argument represents the views of that class of economists who believe that legislation favoring special commercial interests is the great panacea for particular industrial ills. Mr. Joy says he has, in the past, advocated discriminating duties as a remedy, and he still believes that it is "the duty of congress to abrogate the treaty which binds by honor the American nation, notwithstanding the repeated violation of it by England. Britain is honorable in commercial matters only as long as she pleases. If anything is to be gained by dishonest policy, she will not let such a small thing as honor stand in the way."

As to the retaliation of other countries —England, for instance—should the legislation advocated be carried out, the reply of this school of economists is that they would not dare to do this. "Should England retaliate with a like system of duties on American exports, such as beef, pork, grain, and breadstuffs, the cost of living to the labor of England would be increased, and this Britain specially desires to avoid, for she must admit all the necessaries of life free (as she cannot raise them herself) in order to cheapen the cost of manufacturing. This policy is the very corner-stone of England's supremacy. If the British government destroy that policy, the whole commercial supremacy of that country falls." This argument presents nothing new, and it rests wholly upon the principle of protection, as that term is understood by protectionists of the radical sort. Under not improbable political changes the system advocated may meet with increased favor.

A Phase of Foreign Competition.

In an editorial in *Engineering* (London, Jan. 12) referring to the Belgian competition with the English iron industry, the following incident, quoted from correspondence of the *Times*, is narrated. Mr. J. W. Durnford, an architect, wrote to that journal stating that a building contractor placed an order for an iron girder of simple construction with a firm in a certain town. Through delay in delivery, inquiries were made, in the course of which the following remarkable circumstances came to light. The first firm, A, had passed the order on to firm B, who had passed it on to firm C—A, B, and C being English houses in business in midland towns. Finally, the firm C sent the order to a Belgian firm."

In commenting upon this curious shifting of contracts, *Engineering* thinks "it does not much elucidate the problem of foreign competition," although it emphasizes very strongly the fact that foreign competition exists and is strong.

The reason why Belgium and Germany furnish girders for British buildings is said to be that architects and engineers "generally specify such unnecessarily diverse types of sectional material for given work that anything like economical and continuous manufacture becomes impossible. On the continent schools of engineers have determined amongst themselves upon a range of sections of rolled iron and steel suitable for certain duties in given types of work." The introduction of Belgian iron and steel in English markets probably has a wider significance than this rather weak explanation indicates. If the diversity of types spoken of embarrasses English manufacturing, it is not obvious that it would not also similarly affect Belgian and German makers, and this explanation seems much like whistling to keep up courage.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*28386. President Cleveland's Currency Scheme. W. R. Lawson (B M–Jan.) 6500 w.

*28387. Low Interest and Plenty of Money. (Extract.) Alexander John Finlaison (B M–Jan.) 2700 w.

†28413. The Independent Labor Party. J. Keir Hardie (N C–Jan.) 5800 w.

28422. The Nicaragua Canal. (Abstract of article in N. Y. Journal of Commerce.) (R G–Jan. 11.) 1800 w.

†28456. Alien Immigration. Geoffrey Drage (F R–Jan.) 4000 w.

28657. Profit Sharing. Editorial (Ir Age–Jan. 24.) 600 w.

*28688. Tariff Changes and Customs Regulations. Russia, Germany, France, Spain, Italy, United States, Brazil, Ecuador, Peru, Argentine Republic, British India (B T J–Jan.) 6000 w.

28703. The Labor Laws of Belgium (E N–Jan. 24.) 900 w.

*28725. A Phase of Foreign Competition. Editorial (E–Jan. 18.) 1500 w.

*28764. A Dutch Co-operative Town—Agneta Park. From the London Times (I C B–Jan. 18.) 1300 w.

28777. Street Railway Strike in Brooklyn. Ill. (S R G–Jan. 26.) 4000 w.

†28792. Some Material Forces of the Social Organism. John W. Langley (P S M–Feb.) 5000 w.

28796. The Conflict of Labor and Capital. J. J. Ingalls, in the Post-Express (R R–Jan. 26.) 1200 w.

*28813. Money. James A. Quarles (A M C–Feb.) 7800 w.

*28814. What Is Prison Reform and How Does It Concern the Public? W. C. Selleck (A M C–Feb.) 3500 w.

*28815. The Catholic Church and the Coming Social Struggle. Charles Robinson (A M C–Feb.) 2500 w.

*28816. Economic Coöperation. E. M. Burchard (A M C–Feb.) 2500 w.

*28817. Suffrage for Women. Mary Elizabeth Brooks (A M C–Feb.) 4000 w.

*28818. The Coming System of National Credit. A. C. Houston (A M C–Feb.) 3600 w.

*28820. The Republic: Endurance by Means of Revolution. William Macomber (A M C–Feb.) 2300 w.

*28823. The Mohonk Conferences. Frances C. Sparhawk (A M C–Feb.) 2600 w.

28824. Why Northern Wealth Grows Faster Than Southern. Anon. (S Ec–Feb.) 3500 w.

28825. French View of Socialism. (Extract.) Leon Say (S Ec–Feb.) 2500 w.

28826. Fallacies That Fool Fiatists. I. W. Porter, with Editorial Reply (S Ec–Feb.) 3500 w.

28827. Judicial Ignorance of the Law (S Ec–Feb.) 500 w.

28828. Spencer's Ethical System. Van Buren Denslow (S Ec–Feb.) 1800 w.

28829. Social Conditions at the South. G. F. Milton (S Ec–Feb.) 2000 w.

†28830. The Financial Muddle. I. J. Sterling Mortimer. II. William M. Springer. III. Henry W. Cannon (N A R–Feb.) 12500 w.

†28831. Politics and the Farmer. Benjamin F. Clayton (N A R–Feb.) 2500 w.

†28832. Problems in the Indian Territory. Orville H. Platt (N A R–Feb.) 2800 w.

*28839. Should the Government Retire From Banking? W. C. Cornwell (F–Feb.) 2500 w.

*28840. Why Gold Is Exported. Alfred S. Heidelbach (F–Feb.) 1800 w.

*28841. The Programme of German Socialism. W. Liebknecht (F–Feb.) 4800 w.

28872. The Mandamus of the Brooklyn Strike. Editorial (R G–Feb. 1.) 1500 w.

28886. Relocation Necessary—Friction in Our Mechanism of Exchange Is the Bottom Cause of Present Depression. George B. Cowlam (M R–Feb. 1.) 1800 w.

28908. The Story of the Brooklyn Strike. Ill. (E W–Feb. 2.) 2000 w.

28938. The Hon. Thomas B. Reed on "Wealth." (B I S–Jan. 30.) 2400 w.

*28965. The Government and Fair Wages in Engineering Firms. Editorial (E–Jan. 25.) 3000 w.

*28966. The Industrial Situation. Editorial (E–Jan. 25.) 2100 w.

†28984. The President's Currency Plan. W. J. Bryan (A–Feb.) 4200 w.

†28985. Bimetallism and Legislation. C. S. Thomas (A–Feb.) 5800 w.

28991. Inland Waterways—Their Development an Important Factor in the Progress of the South. Anon. (T–Feb. 1.) 2500 w.

29096. The Brooklyn Strike. "Matthew Marshall" in the N. Y. Sun (W E–Feb. 9.) 1200 w.

Serials.

28842. The Social Discontent. I. Its Causes. Henry Holt (F–Began Feb.—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Rule of the Road at Sea.

UPON this important subject, increasing constantly in importance as the number and speed of steamships increase, a spirited debate is reported in *Fairplay* (Jan. 11), the subject having been brought before a meeting of shipowners, merchants, and shipmasters, held at Liverpool on January 8, by an address of the lord mayor, who presided over the meeting. He said that the substitution of steam for sailing vessels had very naturally rendered necessary a reconsideration of the rules at sea, and the Board of Trade had very properly endeavored to meet the altered circumstances by a conference of the maritime powers held at Washington in 1889. Here a code of rules seemed to have been fairly discussed and decided upon, and, as far as he could understand, with practical unanimity, except on two points,—one of these having reference to side-lights of ships, and the other to the form of fog signal to be used at sea in the presence of fog or weather calling for the use of that sign. By the multiplication and duration of a sound signal the captain of a vessel could be supposed to know whereabouts and in what direction another vessel was steering. Upon these two questions a strong difference of opinion exists. At the conference itself 64 per cent. of the representatives objected, and only 29 per cent. approved of the suggested proposals; and—what was still more remarkable—the entire voice of the Liverpool shipowners' associations, the committee of Lloyd's, and many other interested organizations (all of whom might be fairly supposed to be as fully alive to their own interests and the safety of their vessels as the Board of Trade officials) condemned these rules in the strongest possible terms. They hold that, instead of diminishing risk at sea, they would increase it; that they imposed upon captains of ships at a critical moment, when all their faculties were needed in other directions, duties which it would be practically impossible for them to carry out. To those cogent arguments the Board of Trade turned a deaf ear. All parties agreed that there was room for improvement; that, if a simple and efficient indication by light or sound of the position and course of steamships could be devised and agreed upon, it would be an immense gain to all interested; and that it would further seem reasonable that no fresh legislation should take place until all parties were fairly well agreed upon these points.

Mr. T. Gibson Bowles, M. P., said they had been driven there that day by the arrogance of the Board of Trade and by the determination of that department to listen to no representations made by practical men as to the carrying out of the rules which they were called upon to work. The dangers which were to be imposed upon the shipping industry of the country were so great that they could not and dare not remain any longer silent. The subject affected not only the lives of a quarter of a million of British seamen, but property and many other matters. Of course, there were difficulties in the way of getting this matter dealt with. In the House of Commons, if the words "rule of the road" were mentioned, the members, including even the president of the Board of Trade, flew away either to the dining or tea rooms. The Board of Trade seemed to forget that British seamanship was 2000 years old. Signals, in some cases, were very necessary; but, after all, they were only auxiliaries to the rule of the road. The old rule was plain and simple. The vessel that had another on her starboard side had to give way, and that was the rule up to the year 1863. In fact, the whole of the rules of the road were learned from the sea, and were kept short, simple, plain, and undoubted; and, until the Board of Trade began to interfere, it was possible to put the whole of the rules on a sheet of notepaper. It was about the year 1853 that the Board of Trade began, through powers obtained from the merchant-shipping act, to interfere with the rule of the road at sea, taking in course of time the rules into its own hands. Hence arose all these troubles. In 1862 a code of regulations was drawn up, and in that code the old rule that one vessel was to give way to another was abandoned, and the words "should keep out of her way" were introduced. This, of course, created uncertainty and formed an element of danger. Since the time he had mentioned scarcely a year had passed without some small, niggardly alteration being made. In his opinion, the Board of Trade was a kind of departmental cuckoo, which laid its eggs in everybody's nest and produced the most fearful wild fowl.

As to the qualifications of the Board of Trade to formulate rules for marine service, he stated that the former president of the board was a weaver, and the present president a historian, who had to rely upon subordinates, many of whom had perhaps been to sea thirty years ago, but had probably lost their knowledge of the sea in the interval since. He criticised the opinions of Lord Farrer and Mr. Thomas Gray, and said that, according to Mr. Gray, steamers were to be placed in the same category as cabs or omnibuses. Apparently Mr. Gray could not conceive that a ship was a different kind of thing, which cannot be handled as the pedestrian or the omnibus and the cab. The Board of Trade had to obtain the sanction of the admiralty before it could alter any rule, and he was strongly of opinion that the course of the admiralty in invariably endorsing all that the Board of Trade did was a grave dereliction of duty. Speaking of the losses at sea by collision, he pointed out that, while in the years from 1871 to 1875, out of 3513 British ships totally lost at sea, 286 were lost by collision, during the years 1889 to 1893, out of 2451 total losses, 425 ships were lost by collision. These figures showed the large increase in losses by collision; for, while twenty-three years ago one out of twelve ships was lost by collision, now one out of six was so lost. The rules made to prevent collisions were inefficacious and bad.

Their complexity and length, and the many changes that have been made in existing rules, were criticised. The Washington conference was also severely criticised as "utterly inadequate to frame any code of regulations." "In his opinion it would be necessary to revert to the shortness, simplicity, and certainty of the old rules; and they would also have to put into the melting-pot all these new rules, and get a few practical men together to make a new code for the seamen."

Bilge Keels.

ONE of the features of modern marine engineering is the increasing favor with which bilge keels are regarded. The influence of these keels in preventing the rolling of vessels at sea is very marked, and it has also been found in modern yacht-construction that such keels will enable a sailing vessel to stand up to the wind under a heavier press of sail than would otherwise be possible. Another effect is the prevention of slip which occurs in heeling over under wind pressure, in which case the bottom keel does not hold advantageously against the water.

In connection with the influence which rolling of ships may have upon the issue of a naval combat, as illustrated in the engagement between the Chinese and Japanese fleets at Yalu, the influence of bilge keels is broadly discussed editorially in *The Engineer* (London, Jan. 18). The mathematical discussion of the resistance of bilge keels occupies a considerable space in the article, and we shall notice only some of the examples referred to as illustrating their practical effect.

"Sir W. H. White quotes, as an illustration, the work done by the bilge keels of the *Sultan*, which are 420 square feet in area, the period of rolling being longer, and the angle of heel during the single swing quoted being 0.102 circular measure, presumably between 5° and 6°. Under these circumstances the amount of work done appears to be only 1890 lbs. Hence the assistance afforded by the bilge keels of the *Royal Sovereign*, or *Magnificent*, towards the extinction of rolling when the vessel has heeled 17°, is one hundred times that afforded by the smaller bilge keels of the *Sultan* at an angle of heel of between 5° and 6°. The importance of arge bilge keels when a ship is rolling heavily can, therefore, be hardly overestimated, we are inclined to think.

"There is, however, another aspect of this question which may accentuate still more sharply the immense importance of the bilge keel as a constructive feature. It has been conclusively proved that the rate of extinction of rolling of ships under weigh is more rapid than that of ships having no headway. A table quoted in Sir W. H. White's work gives the increase of rapdity in the process of extinction between no headway and eight knots' speed, in a particular vessel, as 50 per cent. The explanation suggested is as follows: 'When the ship is under weigh, she penetrates at each instant into water not yet disturbed, of which the whole inertia has to be overcome, whereas, when she has no headway and is rolled, similar conditions do not hold, and the inertia of the water is not so great.'"

Other examples are cited of ships loaded with live stock whose trampling set up a decided rolling when the vessels lay moored at the side of their docks, although these vessels were steady enough when under weigh. The principle seems clear that, when these keels penetrate water which is practically at rest, the inertia of the water is a factor in the effect they produce. "It seems irrational to suppose that, when such a mass as a vessel weighing many thousand tons is under consideration, a pressure of 1890 lbs. upon the bilge keels would present any effective resistance to the influence of rolling; but, when the size of the bilge keels and of the ship itself increases, so as to make the work done fourfold greater, and when the rapidity of the rolling motion is enhanced so greatly as to develop this work of resistance fifteenfold, still further, the figure of 105 tons stares us in the face. This is by no means a figure to be despised. It is well known that three hundred men, who would weigh about 22 tons, can set a heavy battleship rolling by running simultaneously across the deck. It is reasonable therefore, to suppose that a pressure of 105 tons exerted against an unbroken water surface would possess immense influence in the bringing of a ship to rest after she had started rolling. The same pressure, in its initial degree, would tend to prevent the setting-up of this process."

Electroplating Ships' Hulls.

ELSEWHERE we have remarked that the industrial uses of electricity seem inexhaustible. One of the most important of recent innovations is the electroplating with copper of the hulls of iron vessels. Should the method prove entirely practical, as it certainly seems to be, it will result in large economy to the mercantile marine of the world, and it will, of course, be equally valuable to war-vessels. A vessel 98 feet long has recently been thus electroplated by the Ship Copper-Plating Company of New York, and the operation and method were illustrated and described in the *Scientific American* (Jan. 26). A continuous coating of inch in thickness was thus put on the vessel over "the entire surface below the water line, including the riveted laps of the steel sheets, the keel, the stern, and rudder post." The operation is described as follows:

"The method is a triple one. The bath, which in size is about 5 feet square, is securely placed in position, and, after being shored up against the vessel's bottom, is calked around the edges with cotton and oakum till it is water-tight. Then it is filled with strong acid solution of copper cyanid, and a current of 6 volts and 900 amperes is applied. The action of the cyanid solution is two-fold; it assists in cleansing the plates, and also causes a firm film of copper to adhere in the next stage of the process. The cyanid bath is removed after having been allowed to act for twenty-four hours, and a solution of copper sulphate is substituted. Large copper plates are used as anodes; the current is reduced to 3 volts, and the amperage remains the same. The deposition of copper takes place immediately, and the process continues until copper has been deposited to the thickness of from $\frac{1}{20}$ to $\frac{1}{16}$ of an inch; the current is then stopped, and the bath removed. The deposition of the copper usually requires about 4 days. The coating is closely adherent, and cannot be removed except by chipping with a cold chisel, in which case a portion of the iron usually comes away with it. The lapping of the coatings has been already described. There is no chance for galvanic action to set in, except by a blow, or grinding upon a rock, which might cut through the film. But, after such a blow, the vessel would undoubtedly have to be docked for repairs, and a small bath could be applied to re-copper the defective spot. The plating of propellers will be of particular value, as the least bit of corrosion interferes seriously with their efficiency. Of course, in practice, a large number of tanks or baths would be in use, and it is expected that an ocean steamer of the largest size (600 feet long) could be completely plated in 4 weeks.

"Experiments have been made on the copper coating, using sea-water which has been brought from ten miles out at sea; it is found that this water has no effect on the coating. To Mr. Henry Bergfels, the plater of the tug, much credit is due in the way of overcoming difficulties, which naturally arise in a new undertaking of this description. It is now expected that an elaborate plant will be built to accommodate vessels of large size, if the *Assistance* proves to be all right in actual sea trials. The success of the plating stage of the process is now assured, and all that is needed to demonstrate the success of the process as a whole is a test in actual service, to see if the coating has the permanency which there is every reason to believe it possesses."

Explosions of Steam Pipes.

THE recent frequency of explosions of steam pipes on ships carrying high boiler pressure, which has increased largely since the adoption of triple and quadruple expansion engines, has attracted the attention of marine engineers, who are endeavoring to devise methods whereby these explosions can be prevented, and also, in cases where such explosions seem unavoidable, to prevent the loss of life, and injury to persons, which are now inevitable as the result of such accidents. To this end, Herr H. Gurlt, ex-privy councillor of the German admiralty, in a paper read before Verein Deutscher Maschinen-Ingenieure, April 24, of last year, advocates certain changes in the construction of ships which have met with great favor from marine engineers, and which have been republished in pamphlet form for general circulation. We are informed that this paper is about to be translated into English and Italian, and that it is to be circulated widely among steam-ship owners and the officials of the great navies of the world in the interests of humanity.

Among the changes proposed, the following are the more important, and, though easily executed in building new ships, some of these arrangements cannot be as easily made in floating ships, as additions to their present construction and outfit;—for example, the safety-casing of the steam pipes, which is one of the most important improvements upon present construction advocated. But, under all circumstances, Herr Gurlt regards it as indispensable to make safety-doors and stairs in steamers now having imperfect and dangerous communications between the engine-room and stokeholes and the upper deck, this being a common fault in steamers already afloat, but one which will probably be avoided in future design and construction. In any ship so built it is asserted that no man so unfortunate as to be in the engine-room or stokehole would be able to save his life in case of a heavy escape of steam in the latter. Other safety measures are proposed, one of which is arrangements for automatically stopping the flow of steam into or out of any bursted steam pipe.

In this department for January a statement was made of the breakdowns of steam machinery, from which the proportion of bursted steam pipes for twenty months, beginning with January, 1893, does not seem to be large, relatively to the accidents of other kinds. However, cidents of this kind are yet too freuent; and, if pipes cannot be made rong enough to withstand the pressures the strains to which they are subjected ı ships, the measures proposed to proct life and limb in case of explosion ıght to meet the favor with which they pear to have been regarded.

Steam Life-boats.

THE use of steam propelled life-boats is nstantly increasing. *The Engineer* (Lonɔn, January 18th) describes and illustrates boat of this kind which appears to be a odel of its kind. The machinery is an pecially interesting feature. It is of raham's patent metallic top, two centrifgal pumps, one on each side of the boat e directed by an inclined direct-acting, mpound engine worked by steam of one ındred and fifty pounds pressure, which ımp is fitted with two outlets, one at the ar and the other at the stern. The outlet the stern are also fitted to discharge in an athwartship direction which enables th boat to be turned without a rudder and very rapidly. The boat is thus enabled to keep away from a dangerous position much more effectively than were a rudder alone relied upon. For the purpose the entire weight of the machinery is ten pounds. It is quite doubtful whether any other system of propulsion of equal power could have been made with so little weight.

"As to the manœuvring trials of *The City of Glasgow*, which is the name of this boat, one jet going astern enables the boat to turn a complete circle without a rudder in five minutes, five seconds, with a wind force of six. It took one minute twenty-six seconds to turn the boat with the rudder and with both jets driven right ahead and going at full speed. A number of the directors of the Royal Life-boat Institution were present at this test and it is stated that all were satisfied with the great utility of the vessel and the ease with which it could be handled.

INDEX TO LEADING ARTICLES.

e journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

†28457. The Collapse of China at Sea. S. rdley-Wilmot (F R–Jan.) 5500 w.

*28583. The Rule of the Road at Sea. Abacts of Speeches by the Lord Mayor of Liverol, T. Gibson Bowles, and W. H. Colquitt. 'y–Jan. 11.) 1500 w.

*28617. The Port of London. Editorial (E an. 11.) 1700 w.

*28625. Electricity on Shipboard (E R L– n. 11.) 1600 w.

*28639. Specifications for Building a Steam ssel Suitable for River Navigation. Ill. ıon. (M W–Jan. 11.) 2000 w.

28669. The Electroplating of the Hulls of on Ships. Ill. (Sc A–Jan. 26.) 900 w.

*28724. Steam Lifeboats. Ill. (E–Jan. 18.) oo w.

*28734. The Midship Section of H. M. S. agnificent and the Influence of Bilge Keels. . (Eng L–Jan. 18.) 1600 w.

28808. The Electrical Equipment of the Priscilla." Ill. (E R N Y–Jan. 30.) 1700 w.

28916. An Alluring Proposition—Protection Farmers and Shipping—D. Lubin's Theory. ea–Jan. 31.) 1700 w.

*28968. James Watt and Ocean Navigation. bstract) Professor Elgar (E–Jan. 25.) 4800 w.

*28970. The French Battleships Magenta and Hoche. Ill. (Eng L–Jan. 25.) 1000 w.

*29050. Repairing a Broken Valve Chest. Ill. Harold P. Norton (From the Jour. of Amer. Soc. of Naval Eng.) (P Eng–Jan. 25.) 1000 w.

29088. The Loss of the "Elbe." Editorial (E N–Feb. 7.) 1700 w.

Serials.

16636. Marine Engine Design (M W–Began Oct. 6, 1893—19 parts to date—30 cts. each).

26091. Some Points in Modern Marine Engine Practice (I & I–Began Oct. 12—Ended Jan. 4—13 parts—30 cts. each).

27378. Water-Tube Boilers and Their Application to War Vessels. Ill. J. Nastoupil (A E R J–Began Dec.—Ended Feb.—3 parts—30 cts. each).

27521. The Shipbuilding and Engineering Works on the River Clyde. James Deas (E Rev–Began Nov.—3 parts to date—30 cts. each).

28356. Navigable Diving Vessels. Sidney H. Hollands (P Eng–Began Dec. 28—2 parts to date—30 cts. each).

28471. Brooklyn's Original Source of Water Supply. Peter Milne (F W–Began Jan. 12—2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

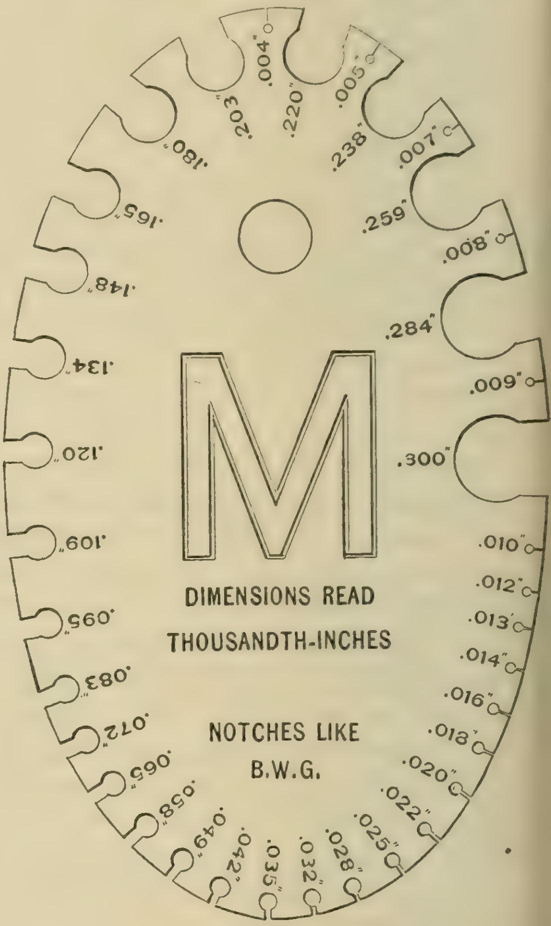
MECHANICAL ENGINEERING

New Design for Wire-Gage.

In this department for February we reviewed Mr. Oberlin Smith's protest against the absurdities of the government wire-gage, and against wire-gages in general, as hitherto devised to meet some arbitrary and irrational standard. Evidently Mr. Smith does not belong to that class who tear down but are unable to rebuild. He has a new design for a wire-gage to offer, based upon the rational division of that unit of measure most widely used by English, speaking nations—the standard inch. In *The Iron Age* (Jan. 24) he proposes the form shown in the engraving, and states valid reasons for its adoption.

Mr. Smith thinks it very desirable that such a gage should be of some distinctive shape which will not be confounded with any of the old gages, thus preventing mistakes. As there are no wire-gages of elliptical form, he therefore proposes that form, and adds that among other advantages are general beauty of contour and convenience for the pocket. This scheme was recently proposed by Mr. Smith before a joint committee of the American Railway Master Mechanics' Association and the American Society of Mechanical Engineers; he states that it "was unanimously, though unofficially, approved by all the members thereof. It was decided by this committee that a desirable method of marking the notches in such a gage was as shown in the sketch, —*viz.*, by the three figures expressing the decimal of thousandths of inches, with a very definitely marked decimal point to the left of the same, and with the usual double 'inch mark' above and to the right. This uniform use of three figures will tend to prevent mistakes in speaking of the sizes in question, which would not be the case if final ciphers were omitted and certain measurements were allowed to be expressed in tenths or hundredths by the use of one or two figures respectively. In such case, were a measurement, for instance, twenty-one hundredths, it would very likely be spoken of simply as 'twenty one thick' or 'twenty-one gage,' in which contingency it could, of course, not be known whether twenty-one thousandths was intended. By the uniform system mentioned, however, such a measurement would, of course, be known as 'two-hundred-and-ten' rather than 'twenty-one.'"

If desired, it would be easy to construct such a gage to four places of decimals instead of three, but this is regarded as a rare requirement. For a name the letter M (Roman symbol for one thousand) stamped on the middle of the plate is suggested, as entirely distinctive from the names now in use, and from this the title M-gage naturally follows.



Design for a Proposed New Gauge.—
(*Full Size*).

"In general, it may be said that the committee above referred to, as well as various other would-be reformers who have taken an interest in this question, have not publicly committed themselves to the advocacy of a national legal gage of this sort. They think that such a tool is needed in the present emergency, and that its use is only in the line of carrying out the system of measuring that they are already doing with the ordinary micrometer gage. These gentlemen are, as far as I know, perfectly willing to consider in future an international gage for the whole civilized world, which may or may not be founded upon the English inch, or the French millimeter, or something else not yet worked out. It is a fact, however, that some practical reform must begin pretty soon, and the suggestions herein made are offered simply for what they are worth, with the hope that some useful points, at any rate, may be included therein."

Mr. Smith offers to assign any right he may have as a designer, should this gage be adopted by a joint committee of the principal national engineering societies, and should they think there would be any advantage in obtaining a design patent for it.

"Referring more in detail to the picture, there is shown therein, drawn to the real size, a gage embodying somewhat the above ideas, and one, moreover, which would be notched and graduated to any desired set of sizes without upsetting the system involved. It would (wherever it happened to have any sizes in common with it) agree absolutely with the Whitworth gage—and with common sense. The particular graduations shown in this case do not fulfil my ideal, as the sizes do not run in a proper series. It is made as it is merely to show how the ordinary B. W. G. gage would look with the proposed new system applied to it, the notches being a copy of the same from 'No. 1' to 'No. 36.' This might be convenient for some of the iron men, whose sizes are pretty well fixed, and the old fogies could have the numbers of the B. W. G. stamped upon the other side of it, if they so desired. It would thus serve as a translator, so to speak, from the old system to the new." This point seems well taken.

Emery Wheels.

THE use of abrasion as a factor in fine mechanical fitting, through the agency of emery wheels and ingenious machines adapted to apply these wheels to various purposes in mechanical construction, has now become a permanent feature of machine-shop practice. It is not likely that, when emery wheels were first invented, their inventors even dreamed of the value of the new resource they were supplying to mechanical engineering; yet to-day there is no other means whereby cylindrical and other forms can be obtained so accurately, and, after the action of a lathe, so expeditiously as by emery grinding. This method, at first confined to burning castings and smoothing rough surfaces, now finds a use in the most refined fitting of journals, piston-rods, interior cylinder surfaces, etc., and emery grinding has come to be an indispensable supplement to the action of other machine tools. In *Industries and Iron* Mr. W. Samuel Worsam, C. E., has recently given information regarding the composition of emery wheels, much of which has not hitherto been familiar even to those who have most extensively used them.

The first materials used for conglomerating emery into solid wheels were glue and treacle, and the wheels so made were of a very inferior quality. The next step in advance was made by the celebrated American inventor, Goodyear, who used india-rubber and gutta-percha as cementing materials These wheels heated under friction, the cementing material softened by the heat, and the wheels glazed quickly. To restore the cutting quality they had to be turned off after the cement at the perimeter had been heated sufficiently to carbonize it. When the chemists Jacques and Fanshaw adapted a material discovered by Walton (inventor of the well-known material, "Lincrusta Walton") to the manufacture of emery wheels, the rapid rise of grinding, as a machine process, into general favor fairly began. Oxidized linseed oil, mixed with about half its weight of shellac, asphalt, or bitumen, was the material employed by these inventors, and the wheels made in this way far exceeded in quality any that had preceded them. These wheels were shown at the London International Exhibition in 1862, and attracted much attention there, and, though many other emery wheels, notably the Tanite, Norton, Bateman, Luke and Spencer, Diamond, Sterling, Sundale, Naxon, Detroit, Celluloid, etc., have since been introduced, the wheels of Jacques and Fanshaw, now called the "Sterne" after their manufacturer, still retain a goodly share of favor. Emery wheels are now made from $\frac{1}{16}$ in. to 8 in. in thickness, and from ¾ in. to 40 in. in diameter. "Their economy in working is marvellous; a man can drive a file about 60 ft. a minute over a flat metallic surface, but it is soon worn out; whereas a well-made emery wheel will work up a surface of 5,000 ft., and last a considerable time without appreciable wear. It has been proved repeatedly by practical men, after careful experiments and observation, that to remove a pound weight of iron with a file costs about 2s. 6d., whilst the same amount of work can be done by a good wheel at the moderate expenditure of 4d.; and, further, the latter will execute the work in about one-eighth less time than the file. An emery wheel will frequently cut away twelve times its own weight of metal before becoming useless. As an instance of the great cutting power of consolidated emery may be mentioned the fact that a disc 12 in. in diameter and only $\frac{1}{16}$ in. thick will cut slits 4 in. long in tough cast-steel ½ in. thick."

"Compound emery wheels are available for many particular operations, and for dry grinding of hot or chilled cast-iron rolls. It is difficult to enumerate the varieties of work for which these wheels, in their different grades, are available; there is a constantly increasing demand for them, and not only have they become a necessity when once adopted, but new fields of application are daily opening to them."

"They are of the greatest service for all kinds of engineer's tool-grinding, saw-sharpening, fettling and trimming castings, grinding chilled rolls, locomotive slot links, plane irons, knives, india-rubber rolls for wringing, printing, and other machines, brushes, eyes, female mandrels straight and spiral rimers, milling cutters, taps, circular knives and slitters, lathe centers, twist drills, etc. Not the least call on these wheels is that for sharpening machine saws. A well made and mounted emery disc, properly worked and running from 6 to 9 hours a day, will last some 3 months, and will gullet, sharpen, and top, on the average, two hundred deal frame saws each day of 9 hours. It is found in practice that the action of the disc on the teeth hardens the cutting points, with the result that the saws last longer when machine- than when hand-sharpened."

Emery wheels are specially adapted to grinding brass, copper, and other soft metals and alloys, and wheels of emery composition are specially suited for decorticating and grinding rice and other grain, and have been found superior to, and more economic than, the French Burr stones.

Limitations in Patent Suits.

A RECENT decision of the United States Supreme Court delivered by Justice Brown *in re* Campbell v. City of Haverhill is one which may in some cases materially affect proceedings for recovery of damages for infringement of patents. *Scientific American* (Jan. 26) says "this action was brought to recover damages for infringement of the claims of a patent, which infringements were committed between October 10, 1877, and December 20, 1880, and was begun more than 6 years after the last date of infringement. It was an action at law, brought in the United States Circuit Court in the district of Massachusetts. The Massachusetts laws declare that a limitation of 6 years applies to all actions of tort,—that such actions must be begun within 6 years of the time when the acts were committed. The Circuit Court decided that the statute of limitations applied to this case. The Supreme Court upholds the Circuit Court."

The United States Revised Statutes (section 721) provide that "the laws of the several States, except, etc., . . . ; shall be regarded as rules of decision in trials at common law, in the courts of the

United States, in cases where they apply." This section has been repeatedly held to apply to the statutes of limitation of different States. The question, then, came up as to whether this section would apply in cases purely within the jurisdiction of the federal courts, such as a patent case, based entirely on the United States statutes. In the words of the decision it is expressed thus: "It may be well questioned whether there is any sound distinction in principle between cases where the jurisdiction is concurrent and those where it is exclusive in the federal courts. The section itself neither contains nor suggests such a distinction."

The opinion of the court is that it would be an anomaly to establish a class of actions subject to no statute of limitations, and therefore holds that actions for infringement of patents should involve no privileges denied to the plaintiff side in other actions. With reference to the natural query as to why this point has not before been settled, the *Scientific American* explains "that the majority of patent cases are brought for present infringement of a live patent, and ask for an injunction and an accounting. Proverbially, there is little money in an accounting; the injunction is the object principally sought. But, in the case just spoken of, the patent had expired, and damages were sought for infringements committed during its life. Such actions are generally regarded as of little value to any one except the lawyers and masters of referees, and hence are seldom brought."

Thermal Value of Fuels.

THE question of the thermal value of different fuels is treated in a practical and satisfactory manner in an article by Mr. E. P. Reichelm in *American Machinist* (Jan. 10). Taking as a common ground for comparison the theoretical number of heat units in equal weights of various fuels, and deducting the average loss by draft and other wastes, he calculates the cost of the net available heat units according to the average price of the fuels considered, and tabulates the results.

"A ton of coal of 2,000 lbs. contains about 28,000,000 heat units, or 14,000 in each pound. Under ordinary conditions the loss by draft, radiation, and the heating of surplus space is estimated at 80 per cent., or 22,400,000 heat units per ton. This leaves available for actual work 5,600,000 heat units, and, assuming the cost per ton of coal to be $4.00, the cost of 1,000,000 heat units would be 73 cents.

"Petroleum theoretically contains 21,000 heat units per pound, or 136,500 to a gallon of 6½ lbs. A fair and moderate deduction for waste is about 70 per cent., which would leave, say, 41,000 heat units as applied to work, from each gallon consumed. At the cost of 3 cents per gallon, 1,000,000 heat units would therefore cost 73 cents, exclusive of the cost of compressed air. This estimate is based upon larger forge fires and ovens, and the loss is greater in heating smaller spaces by reason of the necessity for disproportionately large combustion chambers.

"By the use of gas in properly-constructed furnaces, which secures perfect combustion by the intimate combination of gas with air in exactly proper proportions, the loss of heat is practically limited to that proportion which necessarily escapes with the products of combustion from the vent-holes or from the entrance to heating chambers which contain but very little surplus space. This loss is practically the same for any kind of gas, above the grade of producer gas, if properly used, and amounts to about 25 per cent. of the heat generated."

The table represents the comparative thermal value of fuels as used in forge fires, drop forging, annealing ovens, brass and copper melting, case hardening, muffle furnaces, and kilns. The accuracy of the table has been verified by records of actual daily work, some of which are presented by Mr. Reichhelm, and which correspond with the tabulated statement very closely. The article concludes with the statement that the fuel of the near future will be gaseous. "That no fuel should be used for any mechanical heating operation except it be first converted into gas must necessarily become an axiom in mechanics within a very few years, and only the first cost of the installation of proper gas-making machinery retards rapid progress in that direction. Considering the wonderful improvements constantly made in the perfection of automatic machinery for every conceivable purpose, it seems strange that the generation and systematic application of heat should not have received that attention which its importance in nearly every line of productive industry undoubtedly deserves."

The College Engineer.

A WRITER in *American Machinist*, who signs his article F. P., illustrates how a certain class of graduates from technical institutions (admitted, however, to be a minority) are injuring the engineering profession by bringing discredit, not only upon the schools from which they have graduated, but upon the really able and competent majority of their fellow-graduates. He states that a superintendent of a mechanical establishment lately said, in conversation, that the "technical men" he had employed to work for him were always going to revolutionize matters by doing such "big things," as he termed it, and that they were always taking steps which they assumed (but never quite knew for sure) to be right, and would continually bring out their "theory" in defence of the steps taken ; and, continuing in this strain, he said "that he did not think that the college *professors* knew it all, either."

Regarding this superintendent as having been unfortunate in his selection of technical men, F. P. inquired their names, and recognized among them that of a young man with whom he had formerly been well acquainted,—a typical example of the minority above spoken of. "Having had frequent opportunities to observe this young man's work in college, I noted that he seldom did any original work, always trying to imitate the methods found in books or the work of his classmates, without having any clear idea as to just why he took a particular step in the solution of a problem or the demonstration of a mathematical formula. In the laboratory and testing work he usually followed closely the rules set down by his instructors, filling out reports according to precept, and his whole aim appeared to be to get a good percentage mark on his term record, without appearing to care whether or not he knew anything about what he had been doing. This class of students usually succeed 'by hook or by crook' in securing good class records, and at the completion of their college course are 'turned loose' on the world as 'engineers of good standing,' and are falsely rated on a par with the—I am happy to say—larger percentage of graduates who do know something about their profession. I am loath to say that the systems in vogue for the graduation of engineering students are sorely lacking in their ability to detect these students who have a lack of practical originality, and of debarring them from entering a profession for which they are so little fitted."

Herein is a fine thrust at the system of examination now in vogue in most of our institutions of learning. A system of education should, and does, for the most part, fit a man for some useful work. If it be a special system, it should fit men for special work. At the end of the course, and at stated periods during the course, practical tests of fitness for such special work should be applied. If a man has taken a course in mechanical engineering, he should, so far as a school can make him, come out a mechanical engineer. That will be what the degree conferred upon him at his graduation indicates. Why not test his quality by actual work in the drawing-room that shall call for the exercise of all the qualifications of a mechanical engineer, instead of counting up his marks in a record-book ? Questions may be answered correctly in the class-room without anything like a comprehensive understanding of the full meaning and practical applications of the answer. And, if lessons are conned solely with a view to pass muster in the recitation-room, as is generally the case with the minority under consideration, the answers for which credits are awarded are very often well forgotten long before graduation day. We maintain that a task or tasks could be set in the drawing-room to a candidate for the degree of M E. that would certainly and accurately measure his fitness to receive that honor.

Condition of Uninsured Boilers.

WITH reference to the condition of uninsured boilers, the *Boston Journal of Commerce* quotes the report of Thomas Hawley, State inspector of boilers for Massachusetts. After stating that in 405 boilers inspected 842 defects were discovered, 169 of which were dangerous, and that 88 boilers were not properly inspected, the inspector repeats an observation made in his last year's report, to the effect that uninsured boilers are neither properly inspected or adequately cared for. "It is not uncommon experience to find no one about a steam plant who can tell anything whatever about the condition of the boiler, or with any knowledge of when the boiler has been inspected. It frequently happens that boilers are reported as having been inspected, but, upon investigation, it appears that this inspection, so-called, was merely the opening of the boiler to see if there was any dirt in it. In very many instances the inspection was reported made by some machinist or boiler-maker in the town, and consisted simply in looking for leaks, and did not take into account the pressure at which the boiler was to run, its age, and how much it had deteriorated. So long as leaks did not appear, the owner was satisfied to have it continue in service. Leaks were made the standard of inspection, and the absence of a leak was held to signify that the boiler was safe.

"Boilers insured in boiler-insurance companies are provided with regular inspection ; but the majority of those not so insured are without proper inspection, and whether they are safe or not is a matter about which their owners have very little knowledge. This, it seems to me, is pretty clearly shown by the defects found in boilers inspected, some of which have since been repaired at my suggestion ; but many boilers are still in use, and no apparent attention given to making them safer." A similar state of things exist in other States.

Relative Tests of Cast Iron.

A COMMITTEE was appointed some time ago by the American Society of Mechanical Engineers to investigate the question of uniform standards in test specimens and methods of testing materials. Mr. W. J. Keep, a member of that committee, has presented to the society a monograph on tests of cast iron, which is quoted, with the discussion by other members, in the *Iron Age.* Mr. Keep gives the results, graphically, of a large number of tests, made with the purpose of providing a means for determining the physical quality of a casting of any size or shape from the test record of any test piece which it may be thought best to use. "Relative tests" are defined to be such as are applicable to any case. In such tests any size of test piece might be selected ; and, having made one test record, every other record by the same method is so much greater or less than the original, which is regarded as standard. In the series of tests referred to it was decided to make enough test bars of definite composition and of such sizes as would establish experimentally the relationship between the physical quality of test bars of any size and form that had ever been used for cast iron. "We could then," Mr. Keep explains, "make rules and construct charts by which a test record of one size of test bar could be turned into the record of a test bar of another size. We could reconstruct formulæ which might be found to be incorrect. We could show by diagrams the influence of a change in composition on any size of casting." In the discussion of the paper considerable difference of opinion was developed as to the universal applicability of the shrinkage charts constructed from the experiments, the data for strength not having been worked out.

"MACHINE Shop Milling Practice," by Horace L. Arnold, serially published in *American Machinist* will, we hope, be republished in book form. It ought to take a permanent place in mechanical engineering literature.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

The Machine Shop.

28393. Drilling Machines for Cylindrical Boiler Shells. Ill. Samuel Dixon, Manchester (Ir Age–Jan. 10.) 4000 w.

28521. Chucks and Chucking as Applied to Pattern-Making. John M. Richardson (A M–Jan. 17.) 2200 w.

28522. An Instructive Job of Broaching. Horace L. Arnold (A M–Jan. 17.) 3000 w.

28678. Pattern for a Bonnet. George Guntz (A M–Jan. 24.) 1200 w.

*28849. A New Drawing Instrument. Ill. Harvey D. Williams (S J E–Jan.) 1300 w.

28876. The Standard Castor and Wheel Company's Work. Ill. John Randol (A M–Jan. 31.) 2800 w.

28877. Hints on Designing—An Inside Facing Tool. Ill. William H. Stedman (A M–Jan. 31.) 450 w.

*28918. Steam Hammer Tools. Ill. James F. Hobart (N C B–Feb.) 600 w.

28925. Selecting Change Gears for Screw Cutting. W. L. Cheney (M A–Feb.) 2200 w.

29075. The Richards Molding Machine. Ill. (Ir Age–Feb. 7.) 2000 w.

29114. Shop Tools and Jigs—Heading Small Bolts, etc. Ill. James F. Hobart (A M–Feb. 7.) 3000 w.

Steam Engineering.

28478. The Condition of Uninsured Boilers. Anon. (B J C–Jan. 12.) 2500 w.

28520. Increasing Use of Traction Engines. Ill. (Sc A S–Jan. 20.) 200 w.

28565. Steam Engine Rivals.—Will It Be Superseded by Any Other Power? (B J C–Jan. 19.) 2300 w.

*28571. Intermittent Firing and the Prevention of Smoke. (Abstract.) R. Le Neve Foster (I C T–Jan. 11.) 1800 w.

28578. Proposed Legislation on Boiler Inspection in Michigan. (S V–Jan. 15.) 3300 w.

*28690. Some Causes for Bad Workmen and Bad Work. A Chicago Journeyman Steamfitter (D E–Jan.) 3000 w.

*28736. Liquid Fuel. Editorial (Eng L–Jan. 18.) 1200 w.

*28746. The Temperature Cycle in a Cylinder Wall. E. Thomas Adams, in Cassier's Magazine (P Eng–Jan. 18.) 1700 w.

†28790. Boiler Explosions. Ill. John L. Gill, Jr., with Discussion (P E C P–Jan.) 3500 w.

*28845. Pressure and Impulse in Motive Engines—A Look into the Future. John Richards (I S F–Feb.) 4800 w.

*28848. The Comparison of Simple and Compound Engine Diagrams. John H. Barr (S J E–Jan.) 3300 w.

28881. Fly-Wheel Failures—An Expert Reviews Some of the Causes (B J C–Feb. 2.) 2000 w.

29060. Testing of Steam Boilers. Ill. R. C. Carpenter, with Discussion (H & V–Feb. 1.) 7500 w.

29061. Heating and Drying by the Use of Exhaust Steam and Live Steam Reduced to Low Pressure, Either Separately or in Combination. Alfred A. Hunting, with Discussion (H & V–Feb. 1.) 1500 w.

29116. Cylinder Condensation. W. H. Booth (A M–Feb. 7.) 1100 w.

29143. A Fatal Boiler Explosion—Mashapoag Pond, Providence, R. I. (B J C–Feb. 9.) 1100 w.

Miscellany.

28379. The Relative Values of Different Fuels. E. P. Reichhelm (A E–Jan. 10.) 1500 w.

28380. Air-Pump Capacity. Ill. Charles M. Jones (A M–Jan. 10.) 1700 w.

*28383. Review of Book by M. Witz on Gas and Petroleum Engines. (J G L–Jan. 1.) 2400 w.

28404. The American Gas Furnace Company's Gas Plant and Furnaces. Ill. (Sc A–Jan. 12.) 1600 w.

28409. Portland Cement Works of the Whitaker Cement Company. Ill. (E N–Jan. 10.) 1800 w.

28410. A New Current Meter and a New Method of Rating Current Meters. W. G. Price (E N–Jan. 10.) 1800 w.

*28460. Mechanical Engineering. Editoria Review of 1894 (Eng L–Jan. 4.) 4000 w.

28479. Fallacies in Engineering—Why Some New "Inventions" Failed (B J C–Jan. 12.) 2500 w.

*28491. Emery Wheels. W. Samuel Worssam (I & I–Jan. 4.) 3000 w.

28540. A Final Decision on a Mechanical Filtration Patent (E N–Jan. 17.) 1200 w.

28549. Future Situs of American Manufacture. J. C. Ransom (T–Jan. 15.) 2700 w.

28579. The Gas Engine. Dugald Clerk (S V–Jan. 15.) 2000 w.

28655. Design for a Proposed New Gauge. Ill. Oberlin Smith (Ir Age–Jan. 24.) 1200 w.

*28665. Improved Gas Furnaces. Ill. (M–Jan. 15.) 1600 w.

28672. The Friedeberg Apparatus for Burning Coal Dust. Ill. (Sc A S–Jan. 26.) 1400 w.

28676. A New Screw Thread. Ill. A. M. Powell, with Letter (A M–Jan. 24.) 2400 w.

*28689. Bossing a Job. A. Dept. (D E–Jan.) 1100 w.

28750. A Stone-Cutting, Elevating, Screening, Storage and Conveying Plant. Ill. (E R–Jan. 26.) 700 w.

*28769. The Manufacture of Wood Pulp. Anon. (C T J–Jan. 19.) 2700 w.

28800. Report of the National Association of Manufacturers Organized at Cincinnati (A S–Jan. 26.) 7000 w.

28833. The Statutes of Limitations in Patent Suits (Sc A–Jan. 26.) 600 w.

†28835. A New Form of Water Oven and Still. Ill. Lewis W. Hoffman and Robert W. Hochstetter (J A C S–Feb.) 700 w.

*28850. Test of Sibley Turbines. T. T. Hubbard and G. W. Collins (S J E–Jan.) 1100 w.

†28851. Mechanism of the Pocket Watch. Ill. H. E. Duncan (J F I–Feb.) 6200 w.

†28865. New Weapons of the United States Army. Ill. Victor Louis Mason (C M–Feb.) 8000 w.

28888. Rustless Coatings for Iron and Steel. Abstract of Second Paper of M. P. Wood (E N–Jan. 31.) 3800 w.

28928. The Use of Compressed Air. Charles A Bennett (E M J–Feb. 2.) 1700 w.

28993. The National Convention of Manufacturers in Cincinnati—Proceedings (T–Feb. 1.) 6500 w.

29016. Shafting, Pulleys, etc. C. R. Tompkins (A S–Feb. 2.) 1200 w.

*29043. Mechanical Engineering in 1894 (E Rev–Jan. 21.) 1300 w.

29063. The Quast Gas and Gasoline Engine. Ill. Charles Quast (E R N Y–Feb. 6.) 600 w.

29106. A Valuable Graphic Diagram. Ill. P. M. E. (Pr–Feb.) 1500 w.

29113. A Cheap Transverse Testing Machine and Some Results Obtained by It. William Kent (A M–Feb. 7.) 1500 w.

29115. A Cheap Planimeter, No. 2. Ill. Frank E. Ward (A M–Feb. 7.) 400 w.

29118. The College Engineer. F. P. (A M–Feb. 7.) 1200 w.

†29139. The Greatest of All Rubber Factories. A. M. Stickney (I R W–Feb. 10.) 2000 w.

†29140. Why a Pneumatic Tire is Fast. Sterling Elliott (I R W–Feb. 10.) 3000 w.

29141. An Historical Survey of the Science of Mechanics. R. S. Woodward (Sc–Feb. 8.) 6800 w.

Serials.

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M–Began Dec. 7, 1893—18 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El–Began Dec. 1, 1893—30 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E–Began March, 1894—12 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Radinger (E M–Began April—10 parts to date—30 cts. each).

24338. The Gas Engine. Ill. Anon. (P A–Began Aug. 15—7 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L–Began Aug. 31—12 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Scheffler, Jr. (M A–Began Oct.—5 parts to date—15 cts. each).

25611. Calculation of a Compressed Air Transmission When the Subsidiary Losses of Energy Are Taken into Account—From Professor Unwin's "Development and Transmission of Power" (E M–Began Oct —3 parts to date—30 cts. each).

27423. Repairing Steam Engines. Ill. (S M–Began Dec. 1—5 parts to date—15 cts. each).

27574. The Stresses on Hemp Ropes and Leather Belts Used for Driving. M. Fauquier (P Eng–Began Nov. 30—3 parts to date—30 cts. each).

27594. Erection of a Corliss Engine. Ill. A. S. Mann (Pr–Began Dec.—3 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (M W–Began Dec. 7—3 parts to date—30 cts. each).

27635. The Principles and Practice of Hydro-Extraction. H. B. Ransom (M W–Began Oct. 7—Ended Jan. 11—3 parts—30 cts. each).

27638. Rope Tramways. (I E–Began Nov. 10—2 parts to date—45 cts. each).

27697. Conditions Which Determine the Choice of a Steam-Engine. J. W. Hall (I C T–Began Dec. 7—Ended Jan. 11—4 parts—30 cts each).

28021. Attachments and Conveniences for Universal Milling Machines. Ill. Warren E. Willis (A M–Began Dec. 27—2 parts to date—15 cts. each).

28181. The Use of Compressed Air. Anon. (P A–Began Jan. 1—Ended Jan. 15—2 parts—15 cts. each).

28391. Making 28-Inch Ball Joint Pipe. Ill. (Ir Age–Began Jan. 10—Ended Jan. 17—2 parts—15 cts. each).

28400. The Building of a Locomotive Boiler. W. D. Wansbrough (M W–Began Jan. 4—2 parts to date—30 cts. each).

28401. Boiler Trials. W. H. Wakeman (M W–Began Jan. 4—2 parts to date—30 cts. each.

28745. The Trials of Oil Engines at Cambridge (P Eng–Began Jan. 18—1 part to date—30 cts).

28926. Recollections of the Use of the Steam Engine Indicator. F. F. Hemenway (M A–Began Feb.—1 part to date—15 cts).

28967. On Results of Evaporative Tests on Land Boilers. George Carruthers Thomson (E Began Jan. 25—1 part to date—30 cts).

MINING & METALLURGY

Improvements in Matte Smelting.

SOME rather revolutionary statements about the pyritic or iron-matte smelting processes are presented by Mr. Herbert Lang in a long and interesting article published in the *Mining and Scientific Press.* The author distinguishes two divisions of modern pyritic smelting. One, the Austin process, is characterized by the rapid combustion or fusion of the charge; the other, the gradual reduction method, by slow heating and subsequent fusion of the matte-forming constituents. In the former special arrangements are made for feeding the combustible ores directly into the zone of fusion; while in the latter the furnace is fed in the ordinary way, the ore mixture being fed at the top in layers alternating with the fuel. Mr. Lang inclines strongly to the gradual reduction process, and his paper is mainly devoted to its description. The German system of plain matting, for the extraction of gold, silver, and copper, the slagging of the earthy substances, the reduction of metallic oxids and the preservation of most of the sulphur and the arsenic in the matte, but without much concentration of the latter, and with but slight utilization of the sulphur, etc., as fuel (which are the essential features of recent American practice), is not discussed.

After considering the known and probable reactions between all the elements present, and giving a table showing what occurs in pyritic smelting as distinguished from the old plain matting, the author proceeds to practical details of working and notes,—among others, the following points, some of which are still open to argument. The ores suitable for pyritic smelting are the oxidizable minerals, such as are commonly roasted in other processes, belonging to the class of sulphids, arsenids, and antimonids, embracing pyrite, pyrrhotite, chalcopyrite, blende, mispickel, and probably galena, to which may be added in the course of experience the remaining minerals of these classes; that is, anything which by melting down produces matte or speiss. These are the refractory substances of other processes. For the present the method is limited to gold- and silver-bearing pyrite, and in less degree to ores containing blende and chalcopyrite. Contrary to the practice in lead and copper smelting, the absorbing product for gathering the precious metals (in this case the matte) should be formed in the smallest amount that will be effective; and Mr. Lang claims that in his experience even so small a proportion as one-fortieth of the charge has done good service, while he does not consider the work satisfactory that fails in putting at least ten tons into one, and, with more favorable conditions, a twenty to one ratio should be practicable.

Mr. Austin, who is properly characterized by the author as the real inventor of pyritic smelting, has maintained that enough heat is given out by the internal combustion of a fairly favorable charge to smelt it; but Mr. Lang asserts that the result of the vast deal of experimenting and practical smelting within five years in pyritic furnaces teaches us not to smelt without carbon fuel, but to smelt with a smaller proportion than any other smelting process has ever used or can use. It needs but 4 or 5 per cent. of coke, supplemented with the hot blast, to fuse charges of ordinary difficulty, containing 10 to 20 per cent. of sulphur. Mr. Lang thinks that the furnace managers who have given up the hot blast and condemn its use entirely are in error. He advocates utilizing the waste heat of the slag to heat the blast, instead of special stoves.

As to the speed and capacity of pyritic furnaces and the consequent saving in time and labor, Mr. Lang takes extreme ground in favor of slow work, and says that the essential thing is not to crowd a great deal of material through, but to do good work on what one has. He believes in large furnaces working very slowly, at the same daily capacity as smaller ones fast driven, and urges that the additional cost of plant cuts no figure, while the labor of feeding and tapping are about the same. There should be no heat to spare, the slag being only hot enough to secure separation from the matte, and hence Mr. Lang believes that water jackets are unnecessary, and that thick brick or stone stacks are better, as retaining the heat and not liable to corrosion at the low temperature. "In order to continue slow running with attendant high concentration and cooling of the hearth, it is necessary to return much matte to the charge, the action of which is to heat up the crucible and render tapping easy, while its further combustion, which takes place to quite an extent each time it goes through, effects a desirable enrichment." It is questionable whether this does not involve loss of precious metal in the slag and by volatilization, as has occurred in recharging lead bullion in districts where the lead ore supply was scant; but Mr. Lang is convinced that the regular feeding of matte as part of the charge will be a recognized feature of the process, and to save heat he has devised means for elevating and feeding the matte in a molten condition, in a thin stream which breaks up into particles that are scattered over the surface of the charge.

The author advocates furnaces with vertical sides, and not inverted frustra of cones or boshes and tapered hearths, the idea being to get a greater diffusion of uncombined oxygen from the tuyeres to the level where the heated sulphids are ready for combustion. The furnaces should be run with cold tops. They should be low, and the author goes so far as to say that "a greater depth of charge than four feet, or possibly five, is a grave mistake."

The losses, as in all smelting, are mainly threefold: (1) in slag, (2) in flue dust, and (3) by volatilization. The first two exist to the same extent as in the German system and in lead smelting. Regarding volatilization losses furnacemen are somewhat in the dark, but the highest losses occur when "fire tops" are permitted. Silver, as usual, volatilizes to a much greater extent than gold, as would be expected from knowledge of the behavior of the two metals. In one campaign of three weeks Mr. Lang found the combined slag and volatilization losses to reach 15 per cent.,—a result he attributes to over much experimenting. In another run of 1800 tons of ore his losses footed up 11 per cent. of the silver, part of which was due to experimental bessemerizing of some of the matte. These intolerable losses were experienced under circumstances which suggested the causes and remedies, so that later the savings reached 95, 97, and 102 per cent. of the assay content in different campaigns. The last result, unexpected but not unprecedented, he remarks, serves to emphasize the inaccuracies of assay methods. Bessemerizing is stated to be inapplicable to most argentiferous mattes.

Mr. Lang's general conclusions are that pyritic smelting to-day lacks nothing in conception or in principle or in scope of usefulness, but needs chiefly the effort of scientific adepts and of skilled operatives, the one to make known its underlying principles, the other to carry on its practice; that in looking over its wide field the most profitable immediate application is in the treatment of difficult ores in isolated districts, in fields altogether new, or in supplanting in older localities less effective processes; and that it will supersede (within its range of ores) in the not distant future (1) those processes which fail to yield a high percentage of precious metal, (2) those which, like amalgamation, afford no valuable by-products, and (3) those which, like lixiviation, require costly preliminary experimentation and give an uncertain yield.

Soldering Aluminum.

ONE of the objections hitherto urged against the more widespread use of aluminum as a substitute for other metals has been that it could not be effectually soldered, although for some time inventors had given their time and attention to the matter. *Invention* states that no less than eight English patents for soldering aluminum were taken out in 1893, with probably as many more for the year just closed. Already two or three of these processes, our contemporary is informed, have passed the experimental stage, and are now being used. A difficulty met is that aluminum is very easily oxidized, at least superficially, so that, no matter how brightly polished, it rapidly becomes covered with a thin film of oxid, the latter, however, protecting the metal against further oxidation. The great secret is to make sure that the pieces to be soldered are entirely free from any oxid; otherwise, it is said, it is impossible to join them strongly together.

One process described in *Invention* includes not only a special solder (an alloy of several metals), but also a suitable furnace for keeping the metal at the temperature at which the operation should take place, and also an arrangement of brushes and other tools, with which the surfaces may be scraped and cleaned, so as to get the solder well into the metal. Small pieces can be soldered with the blowpipe, but for large ones some such special furnace is claimed to be advantageous. Good results are reported.

The annual output of aluminum has increased from about fifty tons in 1890 to about two thousand tons in 1893, according to *Invention*, with a large drop in price. It is not now manufactured in England, the companies formerly using chemical processes of production not being able to compete with the electric plants of the United States, Switzerland, and France. A company (the British Aluminum Co.) has been formed, however, for the manufacture of aluminum in England by the processes successfully used in the Swiss and French works. Water power will be employed, and the raw material is to be derived from the north of Ireland.

Stone Coal in the Lead Blast Furnace.

SOME results of runs at the Germania lead works, Salt Lake City, in which lump and nut coal was used in admixture with coke or charcoal or both, are communicated to the *Engineering and Mining Journal* by Mr. L. S. Austin. Details are given of experimental runs in which varying proportions of stone coal were thus used in connection with either or both of the other fuels; and the conclusion arrived at by Mr. Austin is that under favorable conditions as to price of coal and kinds of ore he would certainly advocate the use of coal, satisfied that it could be introduced with profit. He considers that, when mixed with coke, it has much the effect of charcoal in promoting the speed of the furnace. The following suggestions are offered: (1) Coal is not to be used in presence of arsenic and copper in quantity. (2) The feeding of coal should be carefully watched to avoid imperfect reduction. (3) Coal may be profitably used only when the difference in price between it and coke is considerable. (4) The total fuel should be at least one to two per cent. more than if coke alone is used.

New Enterprises in Gold Mining.

AN editorial article in the London *Mining Journal*, discussing the present status of gold mining in the investment and speculative market, after alluding to the revival of interest in the industry brought about by the success of certain gold districts and flattering anticipations in others, says that the immediate result of this popularity of gold mining is certain to be an extension of public interest in new ventures. It is, no doubt, an advantage to the vast majority of investors that they can put money into proved undertakings without much risk of losing it; but, as the *Journal* points out, having to pay for this absence of risk in a smaller percentage of dividend, many investors would prefer to strike out in new directions, and take part in enterprises in which the proved results have not as yet advanced shares to a level inconsistent with profitable speculation. It is surprising that the interest in legitimate mining has not been taken advantage of by promoters in floating more new concerns than have lately made their appearance on the London market; and this the *Journal* considers an indication of the more healthy tone of mining speculation, showing that the public is less credulous nowadays—as it well might be in view of the many hard experiences of the past. "In fact, it seems as if the business of the promoter who floats a company with the sole idea of making a profit at the expense of the shareholders is pretty well played out, or at least the fierce light of criticism which beats upon suspicious undertakings is so efficacious that they are rarely able to survive beyond the preliminary stages of formation." "Investors are quite content to wait before venturing their capital in the working of properties of which the value can at the best be only imperfectly known, and, if the mines prove to fulfil expectations, there will be no lack of capital for carrying out operations upon a sufficiently extensive scale." The reference is here to certain African districts outside the Transvaal, to those of Siam, and more especially to the recent glittering discoveries in West Australia. Some of these latter are undoubtedly rich, but the *Journal* cautions moderation upon the part of newly-formed companies, and impliedly rather disparages the mere "prospects."

While the *Mining Journal* considers the case from the point of view of investors, Mr. T. A. Rickard, writing to the New York *Engineering and Mining Journal*, sounds a timely note of warning to American miners thinking of going to the new West Australia fields, and says that no person should go without purchasing a return ticket, as the journey is a long and expensive one. Mr. Rickard also cites the high prices of provisions, etc., there, and the low wages and scarcity of work—to which is added unusual hardship. He further believes that, "while one or two of the mines are doubless destined to a future of important productiveness, many of those sold recently in London are wildcats of the wildest kind."

Malleable Castings from Coke Iron.

THE manufacture of malleable iron castings has long been an important branch of the American foundry trade, and is a specialty of large establishments in various localities. *Iron Age* considers the desire to attain in them lightness with strength, avoiding clumsiness and appearance of heaviness, to be due to a recognized national trait. Safety and durability are not lost sight of, but surplus metal is avoided so far as possible. "Until recently," says *Iron Age*, "the peculiar excellence of American malleable castings has been attributed in no small degree to the character of the pig iron used. Lake Superior charcoal iron was considered the ideal material, being smelted from very rich pure ore with the purest of fuels." But the same journal reports that coke pig in mixture with charcoal iron is invading this field, and that the former threatens to absorb the whole trade. Two reasons are given for this revolution: first, the demand for cheaper material; secondly, the effort of coke iron producers to widen the consumption of their product. Our contemporary states that the method adopted by the coke iron producers to satisfy requirements is to analyze every carload of iron destined for malleable castings, so that the consumer knows just what he is getting and can determine the exact treatment needed —and this is another triumph for the chemist in metallurgy. To meet these conditions the producer of charcoal iron must not only sell on even terms, but furnish an analysis of each carload; so the mere fact that the iron is smelted with charcoal will not be accepted as a guarantee of uniformity, or even of superior fitness for the special purpose.

Gold Mining in Ecuador.

ECUADOR is less generally known as a gold-mining country than some of her sister republics of South America, and this renders a recent communication of Mr. O. A. F. Saabye to the *Engineering and Mining Journal* of special interest. While Ecuador is not so rich in the precious metals as some other South American countries, for centuries gold has been profitably mined there, west of the Andes, by Spaniards and natives, many old reservoirs and ditches still remaining in a comparatively good state of preservation to bear testimony to the former workings. But it was only a few years ago, says Mr. Saabye, that it was discovered that a new region in the northwestern part of the country, also among the western spurs of the Andes, contained placer gold. The natural conditions of the country being favorable for hydraulic mining, several mining companies were formed by North American capitalists, of which four companies, together holding about 190 square miles, are the most important and are in operation at the present time. These placers are near the Colombian boundary, and about 35 to 40 miles east of the Pacific coast. They are easily accessible and have abundance of water and grade. The auriferous gravel is located at greater or less distances along the streams. Its depth is very variable, running from 4 to 80 feet above bed rock, and nearly always covered with alluvial soil, also of variable thickness. The gold is coarse. As to the richness of the gravel, Mr. Saabye states that the various expert reports, based upon experimental washings, place it at from 25 cents to $2.50 per cubic yard, with a reliable average of 45 to 60 cents. The natives are nearly all full-blooded negroes, and under proper management make good and cheap laborers.

Coal Mining in New Zealand.

FROM the report of the minister of mines of New Zealand, as quoted in the *Colliery Guardian*, the following brief notes are derived. Comparatively few years ago there were only three mines in the colony where bituminous coal was raised, but at present several others are working or preparing to mine this coal. The total number of collieries of all kinds in 1893 was one hundred and fifty-three. A large number of these are merely open pits where lignite is mined for local consumption. Both lignite and brown coal are suited only to this use. So far as known, the whole of the bituminous coal is confined to the west coast of the middle island, and, as this is the only coal suitable for ocean steamers, it is from the mines of this locality that a largely increased output may be looked for. But, before the industry assumes large proportions, foreign markets will have to be found, and for this the superiority of the bituminous coal will have to be relied on, as it cannot compete in price with some other coals. Comparative tests have placed the Westport (N. Z.) coal higher in evaporative power than even the Welsh coals. In 1893 the output from all collieries was 691,548 tons, a small increase over that of the preceding year. The average number of men employed was 1888, with average wages of £107 4s. 8d. ($532).

Gold in Brazil.

BRAZIL, as Dr. J. Branner reminds us in a contribution to the *Engineering and Mining Journal*, was at one time the greatest gold-producing country in the world; but the yield of gold and diamonds was at its height when cheap slave labor was available. This tended to bring mining into disrepute, and to cause it to be considered as degraded and degrading, so that, when the slave trade was stopped, free labor was unskilled, scarce, and also more expensive, wherefore the industry declined. During the last forty years most of the work has been done by single prospectors working with the batea, which of course can only be used with small and very rich placer deposits. The writer quotes from a recent report of Dr. Hussak, a government geologist who has been exploring the high plateau. This authority describes the unworked low-grade deposits, which are (1) lodes and lenticular masses of quartz in mica schists and (2) secondary formations, gravels in ancient fluvial deposits, or the sands of existing streams. Worked on the large scale and with approved modern methods, it is believed that both classes of deposits could now be made to yield a profit.

Metallurgical Progress.

IN an admirable series of reviews of engineering branches in 1894 and forecasts for 1895 the London *Engineer* notes, under head of "Metallurgy," that on the whole there is not much requiring to be chronicled in the metallurgical world on the ground of novelty. In iron- and steel-making the most noticeable feature is the steady increase in size of open-hearth furnaces, these having grown from 15 tons and below to 20 and 25 tons, while 50-ton furnaces are not uncommon. The tendency in blast furnaces is the other way,—to reduce cubic capacity and increase production by larger blowing power and denser blasts. A peculiar form of iron furnace is described, consisting in the substitution of a stack of nearly cylindrical profile with short low boshes and a wide hearth, terminating above in a bulbous expansion or upper boshes, for the usual continuously curved outline and wide boshes. This is stated to be advantageous,—in one case, with a reduction in contents from 33,000 to 22,500 cubic feet, the make being increased nearly 70 per cent., reaching 1000 tons of iron weekly on hematite ores. The blast is 6½ lbs. per sq. in.

The demand for highly phosphorized metal in the basic Bessemer process has caused a return to value of waste cinder dumps in England; hence a scarcity of phosphorus is possible. In the basic open-hearth process pig iron is not required to be so high in phosphorus as when treated in converters.

A new form of open-hearth furnace of French design to some extent combines in one apparatus the Siemens furnace and the Bessemer converter, the latter being represented by two systems of blast pipes, one set at the roof, the other at the level of the bath. Another French design is a regenerative furnace, in which checker-work is entirely dispensed with, the regenerators being replaced by long parallel flues in a mass of brick-work.

The Schönwalder furnace, about two years ago introduced in Silesia, is intended to increase durability, one thousand to twelve hundred heats having been borne in a 14-ton furnace without renewals. The Saniter process of desulphurizing was used in treating 18,000 tons of pig at a Welsh works, removing from two-thirds to seven-tenths of the contained sulphur at a cost reported as not exceeding 6 pence per ton. Very pure basic steel has been made in the open-hearth furnace.

The Austin process of pyritic smelting has been adopted for the concentration of low-grade copper ores of Newfoundland mines into a product for shipment to Wales for refining. Three tons of ore give in this case 1 ton of regulus (matte?).

Electrolytic refining of copper is gaining in favor, the capacity of the works in America being stated by the *Engineer* as more than 60,000 tons annually. The Anaconda refinery at Butte, Montana, has the largest plant for this purpose at present, but the Calumet & Hecla Co., of Michigan, will have works using the Niagara water-power. Electrolytic refining of doré bullion, to separate gold and silver, is stated by the *Engineer* to be preferable to parting by sulphuric acid. A weak solution of nitrate of silver is used.

The further progress of the cyanid process for gold and silver extraction is noted, as also the substitution of electrolytic precipitation of gold in this process on lead cathodes, in place of precipitation by zinc shavings.

The Boss Rock Drill.

THIS drill is a departure in principle and design from other drills, being an attempt to combine the benefits of rotary motion, as in the diamond drill, with the percussive motion of the drills used in driving blast holes. It is described by its inventor, Mr. J. M. Boss, in a paper read before the Mining Institute of Scotland, of which paper an abstract is given in the *Colliery Guardian*. The drill is not connected with the piston, but with an extension piece. The piston is the only moving part in the tool; it moves with short stroke and very high velocity, striking light but excessively frequent blows upon the head of the extension piece, though the impact is communicated to the drill, and the latter is rotated by a rapid hand-wheel motion.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

*28378. The Conquest of Steel Over Cast Iron. Horace L. Arnold (E Mag–March.) 3000 w.

28392. Loam and Dry Sand Molding Compared with Green Sand, as to Its Economy and Adaptation. Simpson Bolland (Ir Age–Jan. 10.) 4000 w.

28406. The Cyanide Patents. H. Bankart (M S P–Jan. 5.) 1000 w.

*28461. Metallurgy. Editorial Review of 1894 (Eng L–Jan. 4.) 1200 w.

*28469. Irish Aluminous Iron Ores and Aluminum Production. Walter J. May (C G–Jan. 4.) 700 w.

*28509. The Properties of Steel. (Extract.) James Riley (I C T–Jan. 4.) 4800 w.

28554. Improvements in Matte Smelting. Herbert Lang (M S P–Jan. 12.) 4800 w.

28561. Magnesia and Sulphur in Blast Furnace Slag. A. D. Elbers (E M J–Jan. 19.) 1500 w.

*28566. The Metallurgical Trades in 1894. Editorial (M J–Jan. 12.) 2600 w.

28604. Castings and Patterns. Editorial (A S–Jan. 19.) 1100 w.

28643. Relative Tests for Cast Iron. W. J. Keep (F D–Jan.) 1200 w.

28644. Foundry Improvements. Ill. H. M. Ramp (F D–Jan.) 1800 w.

28656. Specifications for Structural Steel. (Clay, Cunningham and Stowell) (Ir Age–Jan. 24.) 5500 w.

*28765. Soldering. Abridged from "The Art of Soldering" by William Probert (I C B–Jan. 18.) 1000 w.

*28770. The Lead Industries of the Tyne. Ill. (C T J–Jan. 19.) 2400 w.

†28836. The Determination of Nickel in Nickel-Steel. E. D. Campbell and W. H. Andrews (J A C S–Feb.) 1500 w.

†28837. The Volumetric Determination of Phosphorus in Steel and Cast Iron. W. A. Noyes and J. S. Royse (J A C S–Feb.) 2400 w.

28875. An Account of Some Tempering Processes. Ill. B. F. Spalding (A M–Jan. 31.) 2800 w.

28887. Big Industrial Operations—A Prediction that Pig Iron Will Be Made at $5 a Ton in East Tennessee. (M R–Feb. 1.) 700 w.

28903. The Effects of Different Elements on Cast Iron. Charles Johnson (Ir Age–Jan. 31.) 1400 w.

28905. The Steel Situation in the Birmingham, Ala., District. C. A. Meissner (Ir Age–Jan. 31.) 1500 w.

28917. Method of Casting Chilled Rolls. Ill. Process of Hermann Reusch and Bernard Preu (I T R–Jan. 31.) 1200 w.

28933. A Possible Explanation of Kernel-Roasting. Henry M. Howe (E M J–Feb. 2.) 1100 w.

28992. Methods of Extracting Gold from Ore. Anon. (T–Feb. 1.) 2000 w.

29015. Manufacture of Brass and Bronze Goods. James Powell (A S–Feb. 2.) 1500 w.

*29030. Dry Concentration. Editorial (M J–Jan. 26.) 1400 w.

*29046. Metallurgical Engineering in 1894. (E Rev–Jan. 21.) 1000 w.

*29056. Nickel and New Caledonia. H. W Sullivan (I C B–Jan. 25.) 2000 w.

29074. A Comparison of Basic and Acid Steel Rails. Abstract by J. B. Nau, of a paper by L. Tetmajer (Ir Age–Feb. 7.) 3800 w.

Mining.

*28376. Mine Management and Superintendence. Covington Johnson (E Mag–March.) 3000 w.

*28398. Progress in Mining. Editorial (M J–Dec. 29.) 1600 w.

*28399. New Enterprises in Gold Mining. Editorial (M J–Dec. 29.) 1200 w.

28407. Mining in Nevada County, Retrospective and Prospective. Anon. (M S P–Jan. 5.) 4000 w.

28415. Mining at Bendigo, Australia. T. A. Rickard (E M J–Jan. 12.) 2000 w.

*28435. Mining in Australia—Suggestions for Gold Prospectors by the Government Geologist. D. W. Marrata (C E–Jan.) 3500 w.

*28467. The Coal Industry of the United Kingdom in 1894. (C G–Jan. 4.) 4000 w.

*28468. The Ross Rock Drill. J. Macewan Ross (C G–Jan. 4.) 1600 w.

*28488. The Metalliferous Mining in 1894. Editorial (M J–Jan. 5.) 1600 w.

28517. A Great Drainage Tunnel—Ontario Silver Mine. (Min R–Jan. 3.) 1500 w.

28550. The Minerals of the Appalachian System. W. M. Brewer (T–Jan. 15.) 2700 w.

28562. Gold in the Highlands of Brazil. J. C. Branner (E M J–Jan. 19.) 600 w.

*28619. A Method of Graduating Test-Tubes for the Determination of Firedamp Content. A. Rateau (C G–Jan. 11.) 1800 w.

*28620. The Bruay Collieries in the Pas-de-Calais, France (C G–Jan. 11.) 2500 w.

*28621. Cast Iron Tubing. (Abstract.) Arnold Lupton (C G–Jan. 11.) 2000 w.

†28660. The Indian Coal Industry—Female Labor. Mr. Grundy's Report (I Eng–Dec. 22.) 1500 w.

*28687. Gold Mining in Victoria (B T J–Jan.) 1200 w.

28704. Gold Mining in Georgia—Present Status of the Dahlonega District. W. G. McNelley (M R–Jan. 25.) 1100 w.

28708. African Diamond Mines.—As Reported by Alfred Hale (M S P–Jan. 19.) 700 w.

28714. The Leadville Gold Belt. Ill. A. A. Blow (E M J–Jan. 26.) 1800 w.

*28727. The Collieries of La Haye, Liège, Belgium. (C G–Jan. 18.) 4500 w.

*28728. Damping Coal-Dust in Mines (Extract.) D. H. F. Mathews, with Discussion. (C G–Jan. 18.) 2000 w.

*28767. Gold Mining on the Colar Field. By One Who Has Studied It (Min W–Jan. 19.) 2600 w.

28779. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (A M & I W–Jan. 25.) 1000 w.

28785. Mining Prospects in Rhodesia. Editorial on Report of John Hays Hammond (M J-Jan. 19.) 1300 w.

28929. The Russian Coal Trade (E M-Feb. 2.) 900 w.

28930. California Placer Gold. Ross E. Browne (E M J-Feb. 2.) 1100 w.

28931. The Basin and Bay State Mining Company. H. M. Beadle (E M J-Feb. 2.) 1000 w.

28939. Mining in California—A Review of the Situation Shows the Industry to Be in a Most Prosperous Condition. W. H. Storms (M S P-Jan. 26.) 2000 w.

28940. Along the Colorado River. Engineer (M S P-Jan. 26.) 900 w.

*28973. Coal Mining in Great Britain. Editorial (Eng L-Jan. 25.) 1500 w.

*28974. Mines and Minerals in the Under Waste Lands. Anon. (C G-Jan. 25.) 3000 w.

*28976. A New Mining Motor. Ill. Henry A. Mavor (C G-Jan. 25.) 1800 w.

*28977. Methods of Working at the Bruay Collieries. J. W. P. (C G-Jan. 25.) 600 w.

*28987. Haulage by Compressed Air Locomotives (I C T-Jan. 25.) 1000 w.

†28995. The Raniganj Coalfield. Ill. (I E-Jan. 5.) 600 w.

29018. The Principal Oil Fields of California (A G L J-Feb. 4.) 1200 w.

*29045. Mining Engineering in 1894 (E Rev-Jan. 21.) 1200 w.

29097. Utilization of Culm. From the N. Y. Tribune (W E-Feb. 9.) 900 w.

29098. On the Occurrence of Lignite and Anthracite Around Hudson Bay. Robert Bell (C M R-Jan.) 3000 w.

29100. Mining as an Investment. Robert C. Adams (C M R-Jan.) 4200 w.

29102. The Auriferous Gravels of British Columbia. John B. Hobson (C M R-Jan.) 3000 w.

29103. Notes on Hydraulic Mining in British Columbia. G. M. Dawson (C M R-Jan.) 1400 w.

29104. The Albert Mines and Capelton Chemical Works. S. L. Spafford (C M R-Jan.) 2500 w.

29135. The Minerals of Brazil. J. Ross (E M J-Feb. 9.) 3000 w.

Miscellany.

28713. Gold Production at Home and Abroad. Editorial (E M J-Jan. 26.) 1200 w.

*28729. The Value of Basic Slag as a Manure. (Abstract.) J. E. Stead, with Discussion (C G-Jan. 18.) 3800 w.

Serials.

20413. Mining Methods. Ill. (C E-Began March—11 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—11 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—11 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—11 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng-Began April 27—12 parts to date—30 cts. each).

22710. Science for Ironmongers. Ill. (Irm-Began June 2—15 parts to date—30 cts. each).

25689. A Typical Gold Mine Region—Description of Cripple Creek, Colorado. Ill. Arthur Lakes (C E-Began Oct.—4 parts to date—30 cts. each).

26139. Aluminum. Ill. A. Humboldt Sexton (P Eng-Began Oct. 12—4 parts to date—30 cts. each).

26386. Proper Foundry Construction and the Apparatus to Be Used. Simpson Bolland (T-Began Nov. 1—5 parts to date—15 cts. each).

26826. Open Hearth Steel. Ill. (Ir Age-Began Nov. 15—7 parts to date—15 cts. each).

27329. Coal Mining Economy Up to Date (I C T-Began Nov. 23—5 parts to date—30 cts. each).

27450. Cupola Tuyeres. Edward Kirk (Met W-Began Dec. 8—4 parts to date—15 cts. each).

27700. Aluminium. G. B. E. (I & I-Began Dec. 7—2 parts to date—30 cts. each).

28038. The Extraction of Copper from Alloys by Means of Electrolysis. From Dr. Car Schnabel's Handbook. Ill. (A M S-Began Nov. 24—Ended Dec. 1—2 parts—30 cts. each).

28130. Mining Reports and Mine Salting. Walter McDermott, with Discussion (M J-Began Dec. 22—Ended Dec. 29—2 parts—30 cts. each).

28589. The Mineral Resources of Tasmania. A. Montgomery (A M S-Began Dec. 1—3 parts to date—30 cts. each).

28642. How Iron Is Made. Ill. John Birkinbine, in Cassier's Magazine (F D-Began Jan.—1 part to date—15 cts).

28784. Gold Mining and Milling in the Black Hills (S. Dakota). C. G. Warnford Lock (M J-Began Jan. 19—Ended Jan. 26—2 parts—30 cts. each).

28786. The Mineral Wealth of Siberia; Its Gold Production (M J-Began Jan. 19—2 parts to date—30 cts. each).

28932. Cripple Creek, Colorado. Ill. Edward Skewes (E M J-Began Feb. 2—1 part to date—15 cts).

28975. Charbonnages Unis de L'ouest de Mons, Boussu, Belgium (C G-Began Jan. 25—1 part to date—30 cts).

28978. The Iron Industry in the South of Russia. Paul Bayard (C G-Began Jan. 25—1 part to date—30 cts).

28990. The Mining Industry as a Legitimate and Profitable Business. Milo H. Slater (M I T-Began Jan. 31—1 part to date—15 cts).

29105. Diabase Dykes in the Sudbury Region. T. L. Walker (C M R-Began Jan.—1 part to date—15 cts).

MUNICIPAL ENGINEERING

Emig's System of Water-Supply.

THIS system has for its object the supply of fresher, cooler water than can usually be obtained from the service-pipes in cities. We regard the arrangement as ingenious, and it may prove useful, especially in very warm climates. The illustrated description of it is abstracted from the *Engineering and Mining Journal* (Jan. 26). Fig. 1 represents the entire arrangement, including "a flowing artesian well which has been drilled on the highest elevation near the city or town about to be supplied. The water from the well, instead of coming to the surface, as usual, is turned into the subterranean reservoir, 2, which is far enough below the surface to preserve the water cool and fresh. The water for immediate consumption is drawn from reservoir, 2, through a pipe, 3, which is preferably laid deep enough to be below the influence of surface temperature. The surplus water from the reservoir runs off through a pipe, 4, to a large storage reservoir, 5. The pipe connects with the upper portion of the reservoir so as not to affect its storage capacity, and is provided with a trap, 6, to prevent the passage of air into the reservoir, and a vent pipe, 7, to prevent the water from being siphoned out of the trap. Eight is a valve-chamber in communication with the cold-water main, 3, and 9 a branch pipe leading from the storage reservoir into said chamber.

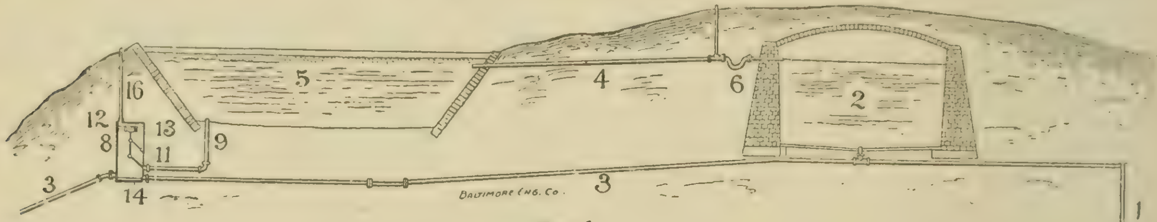
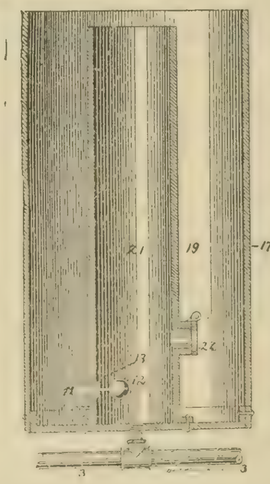


FIG. 1.

"The discharge pipe, 9, of the storage reservoir is automatically controlled by a balanced valve, 11, which may put the main, 3, in communication with the storage reservoir, 5, when the water from the subterranean reservoir, 2, is insufficient to supply the demands upon the main; 11 is a balanced valve in the form of a disc turning on its axis. This balanced valve is controlled by a float, 12, in chamber, 8. The float may be connected to the valve in any suitable manner. The stem, 13, of the float is pivotally connected to an arm, 14, which is rigidly connected to the valve. To prevent air from accumulating in the chamber, 8, a small pipe is run up to the surface of the ground.

"The operation is as follows: under ordinary conditions the cold-water reservoir, 2, remains full of water, as do also the main, 3, and the valve chamber, 8. The float, 12, keeps the valve tightly closed. The surplus water at night, and at other times when the demand is light, flows into and fills the storage reservoir, 5. The cold-water reservoir is large enough to meet any demand for household purposes, but, should a fire break out, as soon as it is drained the water in the valve chamber will be lowered, and the weight of the float descending will open the balanced valve, 11, and admit the water from the large storage reservoir into the main. Thus for emergencies the main is automatically put in communication with a large supply of water, while for ordinary purposes the water is supplied to the consumer directly from the well.



"In a level country, where the water must be obtained at about the same elevation as the point of consumption, a double stand-pipe is used, Fig. 2, which is constructed as follows: 17 is a large stand-pipe, its dimensions varying with the population to be supplied. Twenty-one is a smaller stand-pipe within the larger one. The purpose of this is to preserve the temperature and purity of the water, and is sufficiently large to hold a day's supply. Near the bottom of the stand-pipe is a check valve, 22, which permits water to pass freely from the inner stand-pipe to the outer reservoir, 19, but prevents it from returning. Communication between the storage reservoir, 19, and the cold-water reservoir and main, 3, is controlled by a balanced valve, 11, similar to that shown in the subterranean system, and similarly operated by a float, 12. The valve, 11, is located at or close to the bottom of the storage reservoir.

"The operation of the stand-pipe system is as follows: under ordinary circumstances pure cold water is supplied to the main, 3, direct from the well, and the surplus water is forced through the check valve, 22, into the reservoir, 19. The water is supplied at such a rate that the stand-pipe and tank will be full, thus giving sufficient pressure to the water in the main to raise it to the point of discharge. By the use of the check valve, 22, at the bottom of the stand-pipe the water passes into the storage reservoir, 19, without having to pass over the top of the stand-pipe, and thus much power is saved in filling the outer reservoir. Should the supply of cold water run short on account of stoppage of the pumps, or increased demands, then as soon as the water reaches the level of the float, 12, the latter will begin to descend, and the valve, 11, would be automatically opened, thus putting the main, 3, in communication with the storage reservoir."

The Testing and Care of Water-Meters.

THE use of water-meters has now become so general, especially where some economy in the use of water is needful (this being the case in nearly all large cities), that the question of their accuracy becomes important. In general, when first put in, their indications are perhaps as reliable, within a small percentage of error, as those of gas-meters, but the conditions under which they work are not so favorable to continuous working as are those of gas-meters. An article by Mr. J. C. Whitney, water register of Newton, Mass., in *Fire and Water* (Jan. 26), states concisely what attention ought to be given to water-meters at the time they are placed in service and subsequently.

"Probably the meter has previously been examined by the maker and found to be accurate, but it is important that each department should make its own tests, not only to insure accuracy, but also to have a record which can be produced in case the registration of a meter is doubted by a water-taker. It is suggested that the first test in case of a ⅝ meter consist in running 5 ft. at the rate per minute stated by the maker to be the greatest proper quantity. On this stream the variation from absolute accuracy should not exceed two per cent. either way. The results obtained from carefully running 5 ft. are as satisfactory as from double that quantity, and the test takes less time and water.

"On small streams it is a question as to the rate of the flow on which the meters should be tried; but perhaps a rate slightly in excess of 1 foot per hour—say 1 $\frac{}{10}$ ft.—would be satisfactory. The quantity of water run at this rate need not be more than 1 foot, and probably somewhat less than this would answer, the meter being expected to indicate at least 80 per cent. of the flow. In this second test time can be saved by connecting several and running together. This trial on small streams is also of advantage on account of the full water pressure being on the meters, thus showing any leaks which exist in the packing, and perhaps saving a trip to stop an annoying drip in a house-cellar." The results of tests should be recorded in something like the following form,—"name of meter, pattern, size, number of years in use, amount registered to date, length of tests in minutes, size of orifice, number of feet run, weight of water in pounds, percentage registered, reading of meter at beginning and end of test, and the date of testing."

The meter is then put into service and

entered in a record-book, which will give its entire history, including quarterly readings and repairs, and from which the average age, average amount registered, and cost of repairs will be obtainable, thus furnishing all needed data for comparison between meters of different kinds or of the same kind. The extra expense of monthly readings probably outweighs the benefits that readings of greater frequency than once a quarter would secure.

"At least once in two years a special examination should be made as to the accuracy of the meters in use in the system. The examiner is to be provided with a large pail—capacity about 4 gallons—and two brass caps, one having an orifice of $\frac{1}{20}''$ diameter, and the other ¼". Starting in a street, the first five or six houses are notified not to use any water for half an hour; after assuring himself that no water is being run on the premises, the meter is read, the cap with the orifice is attached to the faucet, and 7½ gallons run, the pail being filled twice. The meter is again read, and any discrepancy noted. The ¼" cap is then disconnected, the $\frac{1}{20}''$ cap attached, water turned on, and the meter matched; if it does not start within a minute on this stream, the examiner notes it, and the meter is taken out for repair as soon as convenient. If it has started properly, it is allowed to run ½ gallon, which on our maximum pressure takes about 3 minutes. Ordinary cases can be detected in this way; doubtful ones may be taken out for more thorough examination."

Gas by Electricity.

THE applications of electricity to the industries of the world are each day multiplying, and their possibilities seem infinite. Among the latest of these is the manufacture of gas for illumination. This gas is, however, not the ordinary illuminating gas, obtained by the distillation of coal in retorts; neither is it the so-called water-gas extensively used for lighting. It is also distinct from the so-called producer-gas used largely in gas-engines. Although the substance produced by the agency of electricity may be used for enriching any of the gases named, and although it exists to some extent in illuminating gas obtained from distillation of coal, yet it is capable, by simple intermixture with common air, of making an illuminant of fine quality. The substance is known chemically as acetylene. It is formed by the decomposition of calcium carbid when brought into contact with water. It is in the production of the calcium carbid from which acetylene is obtained that electricity finds a place. Calcium carbid is formed by subjecting a mixture of lime and carbon to a temperature of from 4500° to 5000° F. This temperature is easily obtained in an electric furnace, but, until recent times, the cost of manufacture by heat produced by electricity has been too great for the commercial manufacture of calcium carbid in this way; improvements in dynamo construction have now brought the cost within practicable limits.

The subject has been discussed by Mr. Slocum, in the *American Manufacturer* (Jan. 11), and also by Mr. Francis Wyatt in *The Engineering and Mining Journal* (Dec. 15), who puts the cost of manufacturing calcium carbid by the electric furnace at $15 per ton of 2000 lbs. Mr. Slocum estimates that packing and freight, and a reasonable profit, would bring the cost up to $30 per ton in the general market. The Wilson Aluminum Company, of Spray, N. C., are stated to be now producing it in large quantities. As to the various uses of acetylene, Mr. Slocum says "that, at the present values, benzole-enriching costs approximately two-thirds as much as acetylene, and naphtha-enriching one-third as much, the values being based on present prices, and accepting the formula Ca C^2 for calcium carbid and the product produced 100 per cent. pure."

The statement is also made "that the acetylene from 1 ton of calcium carbid, mixed with the proper proportion of air (40 per cent.?), will produce a gas equal to 100,000 cubic feet of 25 candle-power city gas. If 40 per cent. of air is the right mixture, the 1 ton of Ca C^2 would produce 17,455 cubic feet of gas. If this gas is equal to 100,000 cubic feet of 25 candle-power gas, it must have a candle-power of 143 candles. This is very interesting; for, when mixed with water gas, it requires 3 grains per candle-power per cubic foot; therefore, to produce 100,000 cubic feet of 25 candle-power gas, it would require 1031 pounds of acetylene, while the light units produced by mixing with air sufficient to equal this only require 720 pounds of acetylene, or, practically, two-thirds as much. The use of acetylene in carbureting water-gas, therefore, is 50 per cent. dearer than when air alone is used with it. It does not seem, after carefully reviewing the above, that acetylene will be used for carbureting purposes in the ordinary gas works of the country. With proper apparatus, however, it can be most profitably used for small isolated lighting, such as seaside hotels or country homes, and will make a most valuable enricher for producing a very high candle-power gas for railroad-car lighting. This last is very important to the gas companies, for it is only necessary to get a compressor and receiver to produce, and supply the railroads with, a very much more satisfactory gas even than that used now in the Pintsch light. The light will be of a higher and more even candle-power, and not subject to a separation by oversaturation."

Philadelphia Highway Improvements.

THE *Proceedings of the Engineers' Club* of Philadelphia contains a paper by Mr. George A. Bullock, on "Highway Improvements in Philadelphia," which, when read before the club, elicited a spirited discussion and brought out some facts worth notice. There are 1325 miles of streets and roads open and in use in the city, of which 869 miles are paved, 426 miles unpaved, and 30 miles are turnpike roads. In December, 1881, an ordinance was passed prohibiting the use of cobble or rubble for paving, and also prohibiting the paving of gutters with brick. The ordinance, however, did not apply to space between tracks of any passenger railway, and it did not affect then existing contracts.

Mr. Bullock says: "The change from block to asphalt paving, and the consequent transformation in the condition of our streets during the last two years, have been due to legislation made by city councils. As a partial compensation for valuable franchises, the passenger-railway companies have been obliged to pave most of our principal streets, and as a result they are now in excellent condition. The railway companies are now operating on 382.64 miles of streets. Another improvement which has been gradually carried forward is the rounding of all street corners. Before this was done, a team could not turn the sharp corner without the horses running into any other vehicle that might be on the track in the middle of the street."

It is estimated that to pave with asphalt the small streets now paved with cobble and rubble will cost from $15,000,000 to $17,000,000; but Mr. Bullock thinks the needed amount will be gradually appropriated and the work will ultimately be done. The street-lighting system is spoken of as "probably the best now in the world." "Not long since a delegation was sent from Paris to inspect it with a view of copying some of its details. Our new building law, although not perfect, contains many improvements over the old law, one of the most important of which is prohibiting the projection of bay windows or fences beyond the building line." Mr. Bullock thinks the time "is near when Philadelphia will be one of the best-managed cities in the world, as it now has the proud distinction of being the one where most citizens live in their own houses."

It has been found that "in asphalt block pavements the blocks rot at the bottom on account of capillary attraction of the moisture from the soil. With proper foundation, however, these blocks make an excellent pavement." In the further discussion it was brought out that the price of gas in Philadelphia differs from that in Berlin, and that there is only a trifling difference in the cost of electric light and water. The cost of maintenance of paving is about three times as much in Berlin as in Philadelphia, but the work is done correspondingly better.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

*28385. Strains in Gasholder Guide-Framing. F. S. Cripps (J G L–Jan. 1.) 900 w.

*28466. Gas Supply. Editorial (Eng L–Jan. 4.) 1500 w.

28481. Gas by Electricity. Ill. F. L. Slocum (A M & I W–Jan. 11.) 1100 w.

*28574. The Efficiency of Non-Luminous Combustion. B. H. Thwaite (J G L–Jan. 8.) 1800 w.

*28666. The Report of the "Lancet" Commission on Incandescent Gas Lighting (J G L–Jan. 15.) 2600 w.

*28667. Dr. Lunge on the Assay of "Refined" Tar (J G L–Jan. 15.) 1500 w

*28739. The Commercial Synthesis of Illuminating Hydrocarbons. Vivian B. Lewes, with Discussion (J S A–Jan. 18.) 6000 w.

*28773. Oil-Gas Enrichment at Huddersfield. William Young (G W–Jan. 19.) 2000 w.

*29007. Oil-Gas Enrichment at Huddersfield. W. R. Herring's Reply to Mr. Young (G W–Jan. 26.) 500 w.

*29008. Interview with Mr. William Young (G W–Jan. 26.) 7200 w.

*29014. Gas of 240-Candle Power—A Sensation—Comments on Vivian B. Lewes' Paper, "The Commercial Synthesis of Illuminating Hydrocarbons" (J G L–Jan. 22.) 1800 w.

29019. How to Burn and How to Save Gas. (Abstract.) W. R. Herring (A G L J–Feb. 4.) 1800 w.

Sewerage.

*28372. Sewers and Sewage Disposal. Rudolph Hering (E Mag–March.) 3000 w.

28519. The Siphon of Clichy-Asnieres. Ill. From La Nature (Sc A S–Jan. 19.) 1200 w.

*28981. Tests of Cement Joints for Pipe Sewers. Ill. Freeman C. Coffin (J A E S–Dec.) 4000 w.

29131. Deer Island Sewerage Works, Metropolitan Sewerage System, Boston, Mass. Ill. (E R–Feb. 9.) 2000 w.

Streets and Pavements.

*28373. Pavements, Sidewalks, Roads, and Bridges. Ill. J. W. Howard (E Mag–March.) 3800 w.

28670. The Boulevard La Fayette, in the City of New York. Ill. (Sc A–Jan. 26.) 1100 w.

†28788. Highway Improvements in Philadelphia. George A. Bullock, with Discussion (P E C P–Jan.) 1600 w.

*28982. The Asphalt Question. S. F. Peckham (P–Feb.) 3500 w.

*28983. How to Determine the Merits of Asphalt—Opinions of City Officials (P–Feb.) 4500 w.

Water Supply.

28426. The Water Scare in Worcester, Mass. (E R–Jan. 12.) 1300 w.

*28465. Water Supply. Editorial Review of 1894 (Eng L–Jan. 4.) 2000 w.

28537. The New Water Supply of Los Angeles. Ill. William Mulholland (E N–Jan. 17.) 900 w.

28559. Bore Hole Wells for Town Water Supply. Ill. Henry Davey (F W–Jan. 19.) 1600 w.

28715. Emig's System of Subterranean Water Supply. Ill. (E M J–Jan. 26.) 600 w.

28755. The Care of a Water Meter. J. C. Whitney (F W–Jan. 26.) 750 w.

†28787. The Filtration of Public Water Supplies. Henry Leffman, with Discussion (P E C P–Jan.) 4500 w.

28883. The Girard, Kan., Water Tank. Ill. (E R–Feb. 2.) 700 w.

28891. The Water Meter as a Sanitary Appliance. Editorial (E N–Jan. 31.) 1000 w.

29089. A Contractor's Opinion of the Jersey City Water Specifications (E N–Feb. 7.) 1000 w.

Miscellany.

†28390. The Work of the London County Council. Sidney Webb (C R–Jan.) 8500 w.

*28464. Sanitary Engineering. Editorial Review of 1894. (Eng L–Jan. 4.) 1500 w.

28754. Fire Departments and Municipal Governments. Gardner Kellogg (F W–Jan. 26.) 1800 w.

28781. How to Supply Our Condensers with Water. John Mabbs. Read before the Robert Fulton Association, N. A. S. E. (S E–Jan.) 2800 w.

*28819. The Elements of Good Citizenship. Fred de Land (A M C–Feb.) 3300 w.

*28821. What the Citizen Owes the State. L. W. Keplinger (A M C–Feb.) 2100 w.

*28822. Civics: A Science for Citizens, and a Creed for Patriots. Henry Randall Waite (A M C–Feb.) 1500 w.

29120. Why Municipal Plants Succeed and Why They Fail. A. E. Winchester (E E N Y–Feb. 6.) 700 w.

Serials.

14839. Water Purification in America (E N–Began Aug. 3, 1893—16 parts to date—15 cts. each).

26221. The Manchester Thirlmere Waterworks (Eng L–Began Oct. 19—4 parts to date—30 cts. each).

27636. The Economic Principles of the Gas Producer. Anon. (M W–Began Dec. 7—3 parts to date—30 cts. each).

28762. Filtration and Purification of Water. Ad. Kemna (I C B–Began Jan. 18—2 parts to date—30 cts. each).

28780. The Artificial Production of Gas as a Fuel. Joseph A. Minturn (A M & I W–Began Jan. 25—2 parts to date—15 cts. each).

RAILROADING

The Gas-Tramway at Dessau.

THE latest innovation regarding means of propulsion on tramways is the application of gas motors directly to cars. A description of Luhrig's system, as carried out on a tramway at Dessau, is presented in the *Journal of Gas Lighting* (London Jan. 1), from advance sheets of *Journal fur Gasbeleuchtung*. The gas-tramway at Dessau commenced regular running on November 15. It is 2¾ miles in length, consisting of two sections,—one 1.55 miles long, the other 0.20 miles. The track is formed with "Phœnix No. 7" grooved rails, set to a standard gage of 4ft. 8½in., and has many sharp curves,—one to a radius of only 40 feet. Besides several easy risers, there is one about 150 yards long, with a gradient of 1 in 30, ending in a sharp curve. The first (longer) section was opened on the above date; the second, on December 6. The provisional rolling-stock is nine gas-motor cars on Luhrig's system. Under one seat of the car is a gas-engine of 7 h. p., the two cylinders of which lie horizontally opposite one another, the pistons working on a common crank axle. The engines are furnished with valve motion and electric igniting apparatus, and were provided by the Deutz Gas-Motor Works.

"The chamber containing the motor is tightly closed beneath and on the inside; but on the outside there are a large folding-door and two small flaps giving access to it. When the doors are shut, the position of the engine is indicated only by the semicircular depression in the casing for the accommodation of the fly-wheel. From the opposite side the car presents the appearance of an ordinary horse or electric car. The spent gases from the engine are expelled beneath without noise. The gas used (ordinary illuminating gas, compressed) is carried by the car in three stout-walled wrought-iron reservoirs, of which the largest is beneath the seat on the side of the car opposite to the engine, the two smaller ones being placed under the body of the car before and behind the wheels. The three holders have a united capacity of 28 cubic feet, and they are filled with gas to a pressure of six atmospheres."

The Dessau cars carry about 66 gallons of water for cooling, and weigh, in running order, about 6 tons, which may easily be reduced in the future. The cars seat twelve persons inside and fifteen outside, thus carrying, with the conductor, twenty-eight people. The speed can vary at will, within wide limits, but the regulations of Dessau permit a maximum of only 7½ miles per hour. A lever on the platform controls the speed. The reversing-gear lever is adjacent, and the brake-handle, with a bell indicator, is also near by. "The trial trip that preceded the opening of the line showed that the cars were easily managed, and that the brake would pull up a car in 2¼ yards when running at the maximum speed. When the car is running, the engine works at the rate of two hundred and fifty revolutions. During short stops it runs free at eighty revolutions, but during long stops it is pulled up and restarted by turning the fly-wheel,—an office easily performed by the conductor.

"At the terminals of each section are two compressing stations, where the gas taken from the street-mains is compressed. The stations consist of a small house, covering a space of about 15 × 15 ft., containing a gas-engine of approximately 8 h. p. coupled directly to the gas-pump. Under a projection roof outside the house are two large boiler-shaped receivers for the gas (compressed to eight atmospheres), as well as the coolers for the gas-engine. From each station a service runs to the street tram-line, where the compressed gas is drawn off from a stand-pipe."

The results are stated to be very satisfactory and encouraging. Immunity from accidents is anticipated from the fact that, although there are no less than twenty-six thousand gas-engines continually at work in Germany, and the majority of German railway-cars are lighted by gas compressed in reservoirs, the explosion of a gas engine or gas reservoir on a railway-car is unheard of.

European Locomotive Boiler Practice.

THE following summary is abstracted from a review in the *Railroad Gazette* (Jan. 11) of a report on European boiler construction by M. Ed. Sauvage, published in a bulletin of the international Railroad Congress Commission.

The use of soft steel sheets for the shells of locomotive boilers is current practice, and it is justified by the fact that these sheets are more uniform in quality than those of iron. The steel should be very soft, as shown by tensile strength, which should not exceed 64,000 lbs. per square in., and should lie between 50,000 lbs. and 57,000 lbs. The plates should come from the best raw materials, and be as free from phosphorus as possible. The use of steel in the place of iron sometimes permits an increase of pressure without increasing the thickness. The manipulation of soft steel sheets does not require great precaution, because they will stand local heating and bending. A desirable precaution is that of annealing the sheets after working and before riveting up. This is not always necessary where long experience has proved the constant quality of the material, and where the workmen are known to be reliable and accustomed to handling steel boilers.

Steel fire-boxes continue to be almost unused in Europe. Some trials have been made which do not indicate that they are much more economical in service than copper,—at least not with the qualities of steel obtainable in Europe. However, with small locomotives having comparatively little work to do, steel fire-boxes may be very advantageous. Tubes of iron or steel are being more and more employed in the place of brass. This substitution may be made without inconvenience, and is a great economy. It is useless to solder an end section of copper on tubes of iron or steel. The iron and steel tubes are rolled or expanded by a mandril in the holes in the tube sheets which are made cylindrical or slightly conical.

The riveted-over part, or bead, on the ends of the tubes at the tube sheet, is not absolutely necessary or indispensable. The ferrules for the ends of the tubes should only be used on the fire-box end. Generally speaking, damage to the tubes can best be prevented by care in handling the boilers. When the tubes are correctly put in, they will give no trouble when the firing is regular and the entrance of the cold air to the fire-box is prevented as much as possible. Boilers should be cool before being emptied, and especially before washing with cold water. It is bad practice to draw the fires before entering stations, as this lets cold air into the fire-box and injures the tubes. Boiler compounds for reducing scale are useful for preventing hard deposits, but the composition must be selected to suit the local conditions and the nature of the water. Purification before using feed-water that is rich in carbonate of lime, and, above all, water containing selenites, is useful, but this plan requires a large outlay for apparatus; yet it often happens that the saving in fuel and boiler repairs and washing gives a final important economy. The introduction of the feed-water into the steam space, which rapidly removes the air from the water, and prevents local cooling of the plates, is worthy of trial.

Locomotive tubes are generally not longer than 13 to 16½ ft. The area of the passage through the tubes ought to be as large as possible, and this justifies omitting the ferrules inside of the tubes at the ends. The diameter of tubes should not be too small, and they should not be brought too close together. The inside diameter should be from 1.6 to 2 in., and the distance between the tube holes in the sheets should not be less than .6 to .7 in. The tubes with wings on the interior, such as those of the Serve type for locomotives, have an outside diameter of 2.4 to 2.8 in., because tubes smaller than this are generally made in too short lengths. It is, perhaps, advantageous to substitute tubes with wings for the ordinary tubes of 2 in.

in diameter, but in that case the number of wings, or the size, should be reduced. The relative efficiency of tubes arranged at the corners of a square,—that is, in vertical and horizontal rows,—and those arranged at the corners of the square with one tube in the centre of the square,—that is, in vertical rows, and not in rows horizontally,—is about the same. Preference is generally given to the arrangement in both vertical and horizontal rows. It is not apparent that there is any particular difference in the capacity of boilers to generate steam, no matter what the metal of the tubes may be,—that is, whether it is copper, iron, or steel.

The effect of the volume of the smoke-box is scarcely appreciable. The long smoke-boxes, such as are used in America, have been tried in Europe by many railroads, but do not seem to give better results than shorter boxes. It seems preferable to use the shorter box. It is not apparent that there is any marked superiority with any type of smokestack. The slightly conical form, wider at the top, seems to be preferred. It is well to prolong the stack into the interior of the smoke-box, using a funnel form for the interior. The height of the exhaust nozzle ought not to be much more than the upper row of tubes.

Almost any form of spark-arrester is, of course, an advantage in reducing sparks, but all interfere with the draft more or less, without being absolutely spark-proof. The simple netting suffices in most cases. The annular exhaust nozzle seems to be the best, but it is complicated in design when the exhaust is made variable. The exhaust nozzle of single blast pipes should be variable, but it is best that the variation does not permit too much reduction in the size of the nozzle. No doubt it is on account of permitting too much reduction of the nozzle that the variable exhaust has been sometimes pronounced injurious or useless. The simple design of two movable wings seems all that is necessary. The height of the exhaust nozzle should not exceed much the top row of tubes, even when the stack is not prolonged into the smoke-box.

The speed has no apparent influence on the production of steam. In other words, the quality of the weight of steam escaping per second with the same terminal pressure in the cylinders is the governing condition. The frequency of the blast has no particular effect. This is shown by the action of compound locomotives with two cylinders.

Gas Jackets for Locomotive Cylinders.

THE *Railway Review* (Jan. 19) reprints from *Engineering* (London) an account of a new system of jacketing locomotive cylinders introduced by L. T. de Kossuth, engineer-in-chief on the Italian State railways. The mechanical details of the system illustrated show that the engines to which the system has been adapted have outside cylinders, to the exteriors of which are fitted casings of metal in two parts, one of which is removable. The casings are made of iron plates with a layer of asbestos interposed between them. Space is left between the casings and the exteriors of the cylinders, and through this space waste gases of combustion are circulated, these gases being conveyed into the jackets by pipes leading from the smoke-box to the casings. These pipes at the smoke-box end are bell-mouthed, and the impetus imparted by the exhaust to the gases forces a portion of them into and through the pipes, and into and through the space under the casings, and through another pipe into the exhaust. The removable half of the casing is for the purpose of cleaning out accumulations of dust, — an operation required every few days. Uniform circulation of the hot gases in the jacket spaces is secured by an ingenious arrangement of diaphragms placed in the spaces.

"This apparatus has been applied on a considerable number of engines in Italy, as well as on locomotives on French and Hungarian railways. A large number of official trials have been made, with a view of ascertaining whether the arrangement offered any advantage in economy of working; and some facts are selected from published results which are of interest and appear representative. The engine referred to is one belonging to the Mediterranean section of the Italian State railways, and has the following leading proportions: fire-box surface, 89.34 sq. ft.; tube surface, 1.248 sq. ft.; grate area, 17.22 sq. ft.; working pressure, 135 lbs. per sq. in.; diameter of cylinders, 17.72 in.; length of stroke, 25.6 in.; diameter of wheels, 52.36 in.; total weight in working order, 39.4 tons; ratio of steam admission, 25 per cent.

"The maximum steam pressure at commencement of stroke was 118 lbs. per sq. in. without reheating. The mean pressure during the stroke was 62.93 lbs. in the former case, and 56.5 lbs. in the latter. These results indicate an economy of 6.43 lbs. per sq. in. in favor of Mr. Kossuth's arrangement. In another series of trials on the same engine, and with a cut-off of 20 per cent., the economy recorded was shown by an increased steam pressure equal to 7.8 lbs. per sq. in. during the stroke. The result of several months' regular service with an engine fitted with the reheating apparatus established an economy in fuel of 11 per cent., as compared with the work done by the engine without the heating device, and with other locomotives of the same type doing similar work. The very interesting facts that have been recorded in the extended trials referred to, and which were of an official character in all cases, together with the distinguished name of the inventor, will probably lead to a practical test of the system in the United States."

Wheel Base for Street Cars.

ENGINEERING NEWS (Jan. 24) calls attention to the fact that increased weight and speed of street cars in the cable and trolley systems of propulsion have rendered it desirable to use double four-wheeled trucks in place of the "short and rigid wheel base" universally employed on street cars drawn by horses. It further states that the four-wheel pivoting trucks first tried have been found unsatisfactory, and that attempts to design the desired extended and flexible wheel base, suited to the needs of these cars, have failed in numerous instances. It prints an abstract of an article by Mr. John A. Brill in the *Street Railway Journal*, describing a design for a four-wheeled truck for eight-wheel street cars manufactured by a Philadelphia firm, and discussing general principles and recent practice in respect of trucks for street-railway cars.

"The general disposition of managers of electric roads is to put cars with 20 or 22-ft. bodies, and 28 to 30 ft. long over all, on four-wheeled trucks. Long cars mounted on four-wheeled trucks, while they possess advantages as regards traction on extra heavy grades over those mounted on centerpivotal trucks, are extremely expensive to keep up. In the first place, no matter how superior the road-bed construction may be, it cannot be mathematically perfect. A long car mounted on four-wheeled trucks is bound to gather at times an oscillating or pitching motion. A moderately-extended spring base has an effect of mitigating this oscillation to passengers, but the pounding on the roadbed is greatly increased by the pitching on the short-wheel base, and cannot be overcome. The result is that for every jump of the car the roadbed suffers. On all tracks there are places beside the curves at which one rail is elevated above the other. The long spread of a truck with 6 or 7 ft. wheel base, as compared with 'maximum traction' trucks having wheel base of 3½ to 4 ft., takes in a large amount of this difference in elevation, and exaggerates the distortion from parallelism of the driving axles and motors. It thus causes a binding of gear wheels, as well as a more rapid wearing away of the cogs, and retards the movement of the motors, thus causing far more strain on the main electric outfit. In my judgment, cars with 18 ft. bodies are the longest that should be used on four wheels. Longer cars should be mounted on 'maximum traction' trucks, so as to overcome all oscillation and the objectionable pounding referred to above. The recent inventions in this style of truck, from which it derives its name, provide for 87 per cent. of the weight on the driving wheels and the remaining 13 per cent. on the trail wheels, just sufficient on the latter to keep them on the track should slight obstructions been countered. The trail wheels being small, and the pivotal center of the truck being within the periphery of the driving wheels, in passing around curves the driving wheels 'radiate' within the car bottom, while the trail wheels 'radiate' entirely beneath the car body, with the bottom frame not exceeding 6 ft. 2 in. for a standard gage track. The height from under size of sill to line of rail is as low as 27¼ in., being ½ in. lower than on regular four-wheeled cars. Another advantage consists in the facility for repairing a damaged motor. One end of the car body can be jacked up, and the single motor and truck run out for repairs, by merely disconnecting the motor leads. If the damage is of a permanent nature, the truck and motor can be replaced by another in a very short time." As to power required to propel street cars with double trucks as compared with cars having single trucks, able engineers positively assert that the double truck has not entailed increased power for haulage.

Electric Locomotives.

We cannot yet agree with the *Boston Journal of Commerce* that the storage battery has been so far improved that it could now be profitably substituted for the trolley for any kind of railroad, as that journal asserts in its issue of Jan. 19. At the same time our faith in the ultimate triumph of the storage battery does not wane, although we believe that it must yet undergo considerable improvement before it can supplant the trolley system. There are some objections to propulsion by the trolley, but the advantages so far outweigh disadvantages that, until this device meets a more powerful rival than the storage battery of the present, it will hold its ground. For street-railway traffic the electric trolley, taken by and large, is the best means of propulsion yet devised by human ingenuity ; but it will not always be so, and all indications strongly point toward the storage battery as the next great step in car-propulsion. And the extension of electric propulsion from street railways to the long lines now using steam locomotives seems also only a question of time. The next generation will, in all probability, ride between distant stations in electrically-propelled, -lighted, and -heated cars, and the locomotive of the present will live only in books and museums. Passing over what has been done in the United States toward effecting this revolution, already familiar to readers of technical journals, it seems that the tendency in Europe is setting even more strongly toward electric propulsion than on this side of the Atlantic.

"Recent information from Europe shows that electric locomotives are becoming rivals of the steam machine, not only for tunnels, but on the long lines of surface railroads. Some two years ago the Heilman locomotive was placed on the tracks as an experiment, and it has proved so satisfactory that one of the older railroads is reported to have ordered several of these engines constructed for its use. This machine, however, is not properly an electric locomotive, as it carries the usual boiler and engine to run the dynamo that furnishes current for operating the motors which give motion to the wheels on the track. There is said to be a great gain in this form of locomotive in the steadiness of movement derived from the electrical balance. Late scientific journals in London report that one road at least has positively adopted electric traction. This is the Paris-Lyons-Mediterranean Railway, which, according to *The Engineer* (London), is now building sixty electric locomotives, each capable of drawing eight hundred tons at a speed of fifteen miles per hour."

The Luehrig gas motor, elsewhere spoken of in this department, is, in the opinion of many, likely to prove a formidable rival to electric propulsion, but it seems yet too early to speak with confidence as to its possibilities.

Electric Traction in Europe.

Apropos of what is said elsewhere in this department regarding the probably near substitution of electric motors for steam locomotives on long lines of railway, and also as sustaining the position that trolley systems are not in immediate danger of being driven out of use by storage-battery motors, a paper contributed to the *Electrical Review* by Mr. Phillip Dawson may be quoted. He says that "the work that has been done, and is about to be undertaken, on the continent is quite sufficient to show the signs of the times. We have repeatedly been told that the trolley car and the trolley wire, so greatly in vogue in America, were hopelessly unsuited to European conditions, and could never find anything like the same general acceptance that has been extended to them on the other side of the Atlantic. The statistics that are to-day available go far to disprove that assertion, and it may now be confidently predicted that by the end of 1895 Europe will be well on the way toward as general an introduction and as wide a use of electrical motive power for both metropolitan and suburban passenger traffic as now maintains in America.

"Nearly 1100 electric motor cars are now in regular operation on the continent alone, employing about 20,000 h. p. in station engines, and approximately 400 miles of track have been electrically equipped. Moreover, contracts are already signed for nearly 500 more motor cars, 12,000 additional engine h. p., and 350 miles of track construction."

Contrary to experience in some of the cities of the United States (notably Brooklyn), Mr. Dawson states that freedom from accident is a marked feature of electric railroading in both Europe and America. This seems to indicate that the accidents of which Brooklyn citizens complain are due, not to electric traction as a system, but to defects in the management of the roads. "On the Halle line in Germany there has been only 1 accident to life or limb for every 88,638 car-miles run. The Berlin horse tramway statistics show 1 accident to every 41,625 car-miles. It may be also said that the speed of the electric cars is much higher than that of the horse cars. These figures are amply supported by American results. In Boston the statistics show a single accident to every 52,475 electric car-miles run. In the State of Massachusetts in 1893 one passenger out of every 686,662 carried was injured, and one fatality occurred for every 106,776,004 passengers carried by the electric lines. The larger part of these accidents were caused by passengers jumping from the cars before they were brought to a stop." Speeds of from 12 to 15 miles per hour are common on country tramways in Europe.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*28369. Relations of the Employee to the Railroad. Cy Warman (E Mag–March.) 3000 w.

*28370. Relations of the Railroad to Its Employees. W. H. Canniff (E Mag–March.) 3000 w.

*28384. The Gas Tramway at Dessau. W. von Oechelhaeuser (J G L–Jan. 1.) 2000 w.

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SCIENTIFIC MISCELLANY

Meteorological Millers.

THE miller's occupation doubtless preceded the mariner's calling in the evolution of industries, yet the use of sails for moving vessels anticipated their use in windmills. The use of sails for either purpose naturally led to a study of weather indications, and, according to a paper by P. J. De Kidder in *Ciel et Terre* (translated and printed in *The Popular Science Monthly* for February), sailors are popularly credited with more than their share of contributions to weather lore. The millers of the windmills are pronounced to be no less sagacious and no less assiduous than sailors in their observations and generalizations of meteorological phenomena, and the way in which the old-fashioned millers of Holland and Flanders observe atmospheric phenomena, as described in this article, is interesting.

"The most intelligent of them observe, according to their own rules, all the changes of the weather. Those of a lesser degree of intelligence are satisfied with noticing the movements of the mills situated farthest in the direction whence the wind comes, and thus regulating the management of their own mills after the example set them by their fellows. These prepossessions of millers concerning the weather should not surprise us, for it is in the line of their direct interest to prognosticate atmospheric changes, and especially to be able to foresee how strong the wind will be, as much for the safety of their mills, which are exposed to all the storms, as in view of keeping on good terms with their customers by properly executing their orders."

The cirrus and cirro-stratus in the southwest as a sign of coming wind delights these millers. They call these clouds "wind trees." "They were as well acquainted with the cirro-cumulus, the alto-stratus, and the cumulus. Proof of this is found in the enigmatical and obscure language of an old miller, who declared he had seen in the sky a shepherd under the shadow of a tree, while the sheep were pasturing in the field.'"

"Besides looking into the nature and meaning of the cirrus and the cirro-cumulus, the miller tried to calculate the force of the wind in distant storms; he observed the direction and velocity of the lower clouds; he estimated at sight the volume and density of the storm clouds; and, if the wind fell off before the rain came, he recollected the old saying, 'A calm comes before a storm.' He especially displays extraordinary vigilance in times of heavy showers. He observes, among other things, if the mills farthest away in the direction of the rain have kept their sails unfolded; if they have, it is a good sign. He scrutinizes the sky at every moment, from the zenith to the horizon; he measures the curvature of the forward part of the precipitation of the storm. The lines of rain or hail that escape from it show him by their length and their approach to the perpendicular how intense the precipitations are. If the lines run obliquely, he is shown the direction of the dominant wind in the squall; in short, no sign indicating the force and direction of the wind passes unperceived by him. He knows likewise that these showers are often accompanied by tempestuous, plunging gusts, which seem to come out of the clouds; and frequently, before the most advanced flecks of the storm-cloud have reached the zenith, the sails of the mill are rolled up around the arms so as to give the squall free passage."

The old miller was the first to discover that "the air is urged on more violently on the right of a squall than on the left." "The storms that passed by on his left, from west-by-southwest to south, never gave him any fear, and he confidently left his sails all unfurled in the wind; but, whenever he was directly threatened with a storm which would pass over his zenith, or which was coming from the right,—that is, from north-by-northeast to east,—at a distance of less than five kilometers, he foresaw the possibility of a strong blow, and took his measures accordingly. I never knew of a miller who could account for the squalls from his left being less formidable than those from his right. The explanation of the phenomenon was reserved for modern meteorology, which has taught us that squalls and thunder-showers constitute depressions in miniature, or at least weak secondary depressions dependent upon a principal depression and formed under its immediate influence."

By such observations the miller became so good a prognosticator of what the weather would be that he could confidently say to a customer when a grist would be ground, and, in making such an assurance, he was rarely in error.

Deterioration of Ammonia in Refrigerating Machines.

AN article in *The Stationary Engineer* calls attention to a curious condition that takes place after a longer or shorter time in ammonia used in refrigerating machines. This change has been observed both in the absorption and compression systems. Its exact nature does not appear to have been determined. It has caused more trouble in the compression system of refrigeration than in the absorption system, but it seems probable that this is due to the greater extent to which the compression system has gone into general use. After a longer or shorter period of running, air and gases are found to have accumulated in the system, and their presence is a puzzle, since the pressure in all parts of the circulating system is greater than that of the exterior atmosphere, and leakage from the exterior into the interior of the system is thus evidently an impossibility. The fact remains that not only air, but other gases accumulate in quantities sufficient to seriously embarrass working, and a liquid of a yet unknown character also forms, creating a further obstruction.

Theoretically, and practically, only pure, anhydrous ammonia is used in charging compression refrigerating machines, and this, so far as known, is a permanent gas, only liquefiable by the aid of cold and pressure, and rapidly volatilizing again, when pressure is removed. The liquid, therefore, which is spoken of as forming in ammonia refrigerating apparatus is a distinct product. It has the appearance of water, but seems to be of a different nature, "because it does not wet the surface with which it comes in contact, as water does. The nature and source of this substance have not yet been satisfactorily accounted for, and its nature and properties are not known."

The experiment of an engineer in charge of a compression refrigerating plant is quoted, as given by himself in *Ice and Refrigeration*. Having found the interceptor two-thirds full of liquid and the action of the apparatus much below the normal standard, he "turned a hot-water jet on the interceptor to facilitate evaporation, and it took about five hours to reduce the liquid to a point in the interceptor where he judged but three or four gallons remained, calculating by the ice line outside of the interceptor. Concluding that the balance remaining must be very weak, he drew it off and found it to be quite lively while being drawn off, as it sputtered sharply and frosted everything it touched. However, in the empty ice-mould in which he drew it, it remained comparatively dead, and it would not evaporate enough to be noticed. After a few hours he emptied the stuff on the stone floor, when it boiled pretty sharply, and in a few minutes had evaporated, leaving a trace of oil and some water on the floor. He adds: 'I had previously been short of ammonia in the cistern for several weeks, but, after pumping out and blowing off the interceptor, I had all the ammonia I needed. On both occasions I tried to purge the condenser and evaporator lower headers, and found nothing of weak or dead liquor on either side. On one occasion the machine was working at 180 lbs. condensing pressure prior to pumping the vacuum, and on the other occasion at 12 lbs.'" His conclusion was that the liquid, whatever it may prove to be, is something produced from the oil used for lubrication, since this is the only other substance that is used in the system. There is here an opportunity for some chemist to distinguish himself by the exact determination of what the liquid is, and how it and the gases alluded to are formed, or how they find access into an inclosure in which nothing but anhydrous ammonia and oil are at first contained, and in which a higher pressure than that of the atmosphere is constantly maintained.

Chemical Fire Extinguishing.

NEARLY everybody is now familiar with the class of chemical fire extinguishers which employ carbonic acid for the purpose of putting out fires in their incipient stages. These exist in quite a variety. Some hold liquefied carbonic acid (called by chemists carbon dioxid); others contain the ingredients for generating this gas, which are made to react upon each other when the gas is wanted. Various acids, as sulphuric, tartaric, and oxalic, have been used, while marble dust (calcium carbonate) has been much used as the article from which to obtain the carbon dioxid by the action of the acid reagent upon the carbonate. Such fire extinguishers, together with the mechanical sprinklers that have come into use, have saved many millions of dollars in the United States and in other lands. But there appears to be no such thing as a standstill in any line of modern improvement, and some new things in the way of chemical fire extinguishing and prevention are coming to the front. Some of these are discussed in *Engineering News* (Jan. 24).

"The modern methods of fire protection by chemicals, which bid fair to entirely displace the old, consist in the use of certain salts which, when heated, give off a gas which extinguishes the fire partly by shutting out the supply of air, and partly by the cooling effect produced by the separation of the gas from the salt. For fire-extinguishing purposes the salt is dissolved in water and used either to fill fire pails or portable extinguishers with a hand force pump and hose attachment. An important advantage is that the salt in solution has little or no corrosive effect, and by the mixture of other substances the solution may be made deliquescent, so that it will not dry away when left in the pails. The effect of such a chemical solution in the extinguishing of fires is truly remarkable. Water poured on a fire, as is well known, has little effect except on the part which it actually touches; but the chemical solution gives off at once a gas which rises and envelops all parts, extinguishing the flame as if an invisible blanket were wrapped about the blazing pieces. Of course, when a fire has been burning for some time, and a body of hot coals has accumulated, the heat actually stored up in the coals must be dissipated in some way. The rapid spread of fire occurs, however, by the spread of the flames, and the influence of the chemical solution in checking this is equal to the effect of a volume of water many times as great, with the additional advantage that the gas will rise and check the flame in closed spaces, such as hollow partitions, where water cannot reach. The expense of the chemicals is not great, especially in view of the fact that the necessity for their use is a rare occurrence."

It is further stated that an oil fire may be as readily extinguished as any other, and that the use of the same chemicals enables wood and textiles to be rendered fire-proof. The names of the chemicals are not given, as some of the processes are kept secret. Ammoniacal salts, with, perhaps, some admixture of chlorids, are inferred, but *Engineering News*, which claims to have been several months investigating the merits of the new methods, expresses the conviction "that by this use fire risk and losses may be materially diminished."

Rare Earths of Chemistry.

THE so-called earths are oxids not easily reduced by ordinary methods. They are insoluble in water, and are scarcely or not at all altered in their chemical characteristics by high temperatures, although physical changes in them may be thus produced,—as with clay which from a plastic state is changed to a stony texture by heat. Clay, lime, and magnesia are earths familiar to everyone. The so-called "rare earths" are oxids of the following substances: cerium, lanthanum, thorium, yttrium, zirconium, didymium, and erbium. According to the *Progressive Age* (Feb. 1), the term "rare" is no longer applicable to these earths, since they are now used largely in the manufacture of mantles for the Welsbach light, the demand for this industrial use having caused them to be sought for and found in considerable quantities. It is asserted that they are now produced by the ton "at a cost not fancy, but commercial."

"Dr. Carl Auer von Welsbach, an Austrian chemist of high standing, has been more active than any one else in the study of the practical applications of these 'rare earths.' The lamp that bears his name is evidence of the fact. Dr. Auer was the first to split didymium ; one portion (possibly an element), on account of its giving green salts, he called praseo (green) didymium, the other neo (new) didymium. Didymium, from didymos, twin, was so named because it so closely associated with lanthanum. In this country some research has been made, as is well shown by the following extract from an article on 'Chemistry at the World's Fair,' by Dr. Marcus Benjamin, who was one of the judges in that department. It is found in *The Chautauquan* for December, 1893.

"'These earths are particularly fitted for use in the Welsbach mantles or hoods, possessing in a higher degree than other known substances the property of becoming incandescent at comparatively low temperatures.' Speaking of chemical exhibits at the Chicago Exposition, *The Chautauquan* said that 'perhaps the most remarkable exhibit of chemical interest is that made by Waldron Shapleigh. This chemist was called upon to study certain of the rare earths, especially in their relation to incandescent burners, for which purpose it became necessary for him to separate them on a large scale, and to obtain them in great purity. The researches of chemists abroad had shown that the so-called element didymium was a compound, but it was not until Mr. Shapleigh took the matter up that this fact became a reality beyond doubt. This work corroborated the results obtained by spectroscopic analysis, and the old element yielded place to the newer neo-didymium and praseo-didymium, each of which is represented by a beautiful series of salts, and, curiously enough, each element is characterized by salts of the same color,—that is, one series in pinkish and the other green. Salts of such rare elements as erbium, yttrium, thorium, lanthanum, and cerium are also shown by him.' . . . . Results such as Mr. Shapleigh has obtained would be recognized abroad from one end of the continent to the other." The sources of supply for these substances are now kept secret, but *Progressive Age* intimates that they are likely to be found in quantity in North Carolina and Northern California. Further particulars of the chemical and physical properties of these substances complete the article noticed.

Artificial Gems.

In line with what was said in this department in February as to the scientific mysteries of the ruby, the *Boston Journal of Commerce* (Feb. 2) prints an interview of a Washington correspondent with Prof. F. W. Clarke relative to the probable manufacture, in the near future, of diamonds of marketable size.

Prof. Clarke, it is stated entertains the belief that this will soon be done. "Moissan, in Paris, has manufactured diamonds by melting wrought iron together with carbon and permitting the mixture to cool very slowly. Under these conditions the carbon became crystallized. Simultaneously Kroustchoff, in St. Petersburg, has got diamond crystals by a similar process, employing silver instead of iron. These artificial diamonds are scarcely big enough to be seen with the naked eye, but they represent the solution of the problem of crystallizing carbon. So much being accomplished, it may be confidently expected that crystals of greater size will soon be produced. It has been argued that in the laboratory the processes of nature can only be imitated on a contemptible scale; but you must remember that crystals of carbon need not be very big in order to possess value as gems."

As to the way diamonds are formed in nature, much speculation has been indulged in, and as yet nothing is certainly known. Upon this point Prof. Clarke thinks some warrant for a shrewd guess can be obtained from facts relating to the great diamond field of South Africa. "There eruptive matter from deep in the earth seems to have burst out through a surface layer of shale, the latter being very rich in carbon. Slow cooling followed, and the carbon was crystallized out, as in the experiments of Moissan and Kroustchoff."

Imperfect garnets have been made artificially. Peridots (crystallized transparent olivine) are also produced. So-called artificial pearls, which are good imitations, but which by no means equal real pearls, have been manufactured for a considerable period. The best of the imitation pearls are beads cut from mother of pearl and coated with silver. The specific gravity of these factitious gems and their luster is about the same as that of gray pearls. The silver coating, however, is not permanent, and, when it wears away, the false character of the gem is fully revealed. Art has never been, and probably never will be, able to rival nature in pearl-making.

The World's Carrying Trade.

FROM a paper in *The Contemporary Review* by Michael Mulhall, the following leading facts relative to the carrying trade of the world are gathered. The people of the British Empire own more than half the ocean vessels of the world, and fifty per cent. of the annual savings of the nation is expended in building new ships and railroads. Since 1840 the tonnage of British shipping has trebled, while that of all other nations has only doubled. Fifty years ago British shipping held one-third the carrying trade of the high seas. To-day it holds over one-half. Sailing vessels have now an aggregate carrying capacity of only one-fifth that of steam-vessels. The decline of tonnage of sailing vessels since 1860 has been four million tons. The increase in trade has not fully kept pace with increase of tonnage, which gives color to the assertion made in some quarters that the business of transportation, like other industries, has been developed to a point beyond existing needs. The greatest increase in port-entries is found in the colonies and South America. The tendency in ship-building at present is toward increase of size.

Turning next to the railway carrying trade, we find that there are now in operation 410,000 miles. This would be sufficient to girdle the earth at the equator about sixteen times. The total cost of these railways has been $3,073,400,000,000. Of existing railway mileage 99 per cent. has been built since 1840. Since 1860 the average annual railway construction has been 10,000 miles. Railway traffic has reacted upon marine traffic to largely increase the latter. In 1850 the cost of land carriage was eight times as much as it is in 1895.

While Great Britain holds supremacy in ocean traffic, the United States is far in advance in railway traffic, doing two-thirds of all the railway transportation of goods, and owning one-third of the total railway mileage of the globe.

The navigable waterways of different countries (rivers and canals) are, in miles, as follows: Britain, 3810; France, 7730; Germany, 17,080; Russia, 33,920; Austria, 7200; Canada, 3360; United States, 51,820; Brazil, 22,000. The carrying capacity of vessels navigating lakes and rivers of the United States is 9,300,000 tons. Of the total carrying traffic of the Suez Canal, British vessels do 76 per cent. The net profits of this canal in 1892 amounted to 8.5 per cent. of the cost of its construction.

Turpentine and Its Derivatives.

CRUDE turpentine is a gum which exudes from a number of varieties of pine trees when they are tapped, or when cavities are cut in their trunks. The gum oozes out slowly, and, after a sufficient quantity has issued from the openings, collections are made. Pine trees freshly tapped yield the best quality. The quality deteriorates and the yield gradually diminishes when trees are tapped year after year. Distillation of the crude gum causes it to yield spirits (sometimes called "oil") of turpentine. Quoting the *Commercial Bulletin*, the

Scientific American Supplement describes a process which, though apparently simple, requires care, skill, and judgment for its successful conduct.

"The stills will hold ten, fifteen, twenty, and sometimes forty barrels of gum. This is 'charged' in at the top, and the cap fitted on. This cap connects by an arm with the worm, around which cold water is constantly running. When the still is filled and this connection made, the fire is applied. As the process of distillation goes on, the distiller adds, from time to time, a little water to prevent scorching, and tries his 'charge' by inserting a rod in a small hole in the top of the still, intended for that purpose. When the process has reached a certain point, he draws his fire, and allows the still to cool a little; then he takes off the cap, and from the liquid mass inside skims off the chips and bark, of which there is always more or less in the gum. If the cap is taken off too soon, the whole charge will take fire from rapid oxidation. When the hot resin is cooled down, it is drawn off through a pipe at the side of the still near the bottom, and passes through strainers into a wooden tank, from which it is dipped into barrels. Upon the care taken in straining the resin depends much of its value in the market; hence certain brands made by careful men soon become known and command high prices. The spirits, being condensed in the worm, run out, mingled with considerable water, into a tub, the water, on account of its great specific gravity, settling at the bottom. From this tub the spirits are siphoned off into well-glued barrels for shipment." It is added that a little carelessness may result in a fire which will destroy in a day 2 or 3 years' profits.

Of tar it is said that in the South it is made "by simply arranging an earthy covering over fat, light wood, thus confining the heat within in such a manner that the drops of fat (inflammable substance) exude through the outer covering. Lampblack is made from this crude tar, for marking cotton bales, boxes, etc., and the negroes use it for staining into solemn blackness the home-made coffins, made of hard pieces of boards, in which they bury their dead." A landowner renting his land to the distillers usually charges about $10 a hundred trees for each season, according to the number of boxes he allows cut in each tree." Those who make the distillation of turpentine a business are itinerant, going about to different locations, where they can get trees. They are said not to be in the best repute for honesty.

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INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

28402. America's Relation to the Advance of Science. (Extract.) G. Browne Goode (Sc–Jan. 4) 2500 w.

28403. The Humanities. J. W. Powell (Sc–Jan. 4.) 3000 w.

28411. Engineering Facts vs. Credulity. George Y. Wisner (E N–Jan. 10.) 1800 w.

28412. The Cost of Hydrographic Surveys (E N–Jan. 10.) 700 w.

28416. Mond's New Process of Obtaining Chlorine. Ill. (E M J–Jan. 12.) 1300 w.

†28503. On a New Specimen of Cladodus Clarki. Ill. E. W. Claypole (A G–Jan.) 2200 w.

†28504. The Columbia Formation in Northwestern Illinois. Oscar H. Hershey (A G–Jan.) 5700 w.

†28505. The Munuscong Islands. Ill. F. B. Taylor (A G–Jan.) 2500 w.

†28506. The Age of the Galena Limestone. N. H. Winchell (A G–Jan.) 1800 w.

†28507. Acidic Eruptives of Northeastern Maryland. Charles Rollin Keyes (A G–Jan.) 2000 w.

28563.—$1. The Cape York Ironstone. R. E. Peary (B G S–Dec. 31.) 15700 w.

*28637. Engineering Fallacies. Editorial (Eng L–Jan. 11.) 2000 w.

28675. Weight and Mass. De Volson Wood (A M–Jan. 24.) 1500 w.

*28692. Recent Work of Elihu Vedder. Ill. W. C. Brownell (Sc M–Feb.) 2600 w.

28702. Chemical Methods of Preventing and Extinguishing Fires (E N–Jan. 24.) 1200 w.

*28726. Flameless Explosives. Editorial (E–Jan. 18.) 2200 w.

*28733. Science in 1894. (Eng L–Jan. 18.) 2200 w.

We supply copies of these articles. See introductory.

*28735. Acetylene as an Illuminant. Editorial (Eng L–Jan. 18.) 1600 w.

*28748. Artificial Light. (Tr–Jan. 18.) 2200 w.

28783. The Deterioration of Ammonia in Refrigerating Systems. Anon. (S E–Jan.) 1800 w.

†28791. The United States Geological Survey. Charles D. Walcott (P S M–Feb.) 9000 w.

†28793. Windmills and Meteorology. P. J. de Ridder (P S M–Feb.) 900 w.

†28794. Science in Education. Editorial (P S M–Feb.) 1400 w.

†28834. An Examination of the Atmosphere of a Large Manufacturing City. Charles F. Mabery (J A C S–Feb.) 4500 w.

*28843. The Outlook for Decorative Art in America. Frank Fowler (F–Feb.) 3700 w.

†28855. Annual Review of Science and Industry. (Abstract of Secretary's Report) (J F I –Feb.) 7000 w.

†28856. On the Relation of Gravity to Continental Elevation. T. C. Mendenhall (A J S–Feb.) 1600 w.

†28857. Observation Upon the Glacial Phenomena of Newfoundland, Labrador, and Southern Greenland. G. Frederick Wright (A J S–Feb.) 3300 w.

†28858. On the Recurrence of Devonian Fossils in Strata of Carboniferous Age. Henry S. Williams (A J S–Feb.) 2800 w.

†28859. Constituents of the Cañon Diablo Meteorite. Orville A. Derby (A J S–Feb.) 2400 w.

†28860. The Inner Gorge Terraces of the Upper Ohio and Beaver Rivers. R. R. Hice (A J S–Feb.) 3000 w.

†28861. The Glacial Land-Forms of the Margins of the Alps. Hugh Robert Mill (A J S–Feb.) 2300 w.

†28863. Lower Cambrian Rocks in Eastern California. Charles D. Wolcott (A J S–Feb.) 800 w.

†28864. On the Pithecanthropus Erectus, Dubois, from Java. O. C. Marsh (A J S–Feb.) 1000 w.

28878. Gems Made to Order—Chemists Are Now Making Several Kinds of Precious Stones. (B J C–Feb. 2.) 1000 w.

28946. Professor Lowe's Experience with Balloons. (Sc A–Feb. 2.) 2800 w.

28949. Tar, Pitch and Turpentine. (Sc A S –Feb. 2.) 2200 w.

28956. The "Rare Earths" of Chemistry. Editorial (P A–Feb. 1.) 1600 w.

†28979. On the Influence of Magnetism on Chemical Action. F. A. Wolff, Jr. (A C J–Feb.) 5500 w.

*29017. Some Early Terrestrial Magnetic Discoveries Pertaining to England. L. A. Bauer (N–Jan. 24.) 2700 w.

*29040. Engineers of To-day and Yesterday. I. Edward Millar Gard Eddy. II. James Deas (E Rev–Jan. 21.) 3000 w.

*29049. Presidential Address of E. Hazel. (P Eng–Jan. 25.) 2500 w.

†29080. The Geologic History of Missouri. Arthur Winslow (A G–Feb.) 3000 w.

†29081. Further Observations on the Ventral Structure of Triarthrus. Ill. Charles E. Beecher (A G–Feb.) 3500 w.

29086. Preservative Coatings for Iron Work. A. H. Sabin (E N–Feb. 7.) 3200 w.

29099. Charcoal; Its Bearing on the Utilization of Our Forests. T. J. Drummond (C M R –Jan.) 6000 w.

29101. Mineral Waters. J. T. McCall (C M R–Jan.) 3000 w.

29107. Chimneys and Draft. E. D. Meier (Pr–Feb.) 3000 w.

29134. The Ancient Coinage of China (E M J–Feb. 9.) 900 w.

†29136. Rubber Tires at the New York Cycle Show (I R W–Feb. 10.) 5000 w.

†29137. The Work of the Brazilian Rubber-Tree Tappers. M. F. Sesselberg (I R W–Feb. 10.) 2000 w.

†29138. Hard Rubber Casting Patterns. John T. Usher (I R W–Feb. 10.) 1200 w.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I–BeganMay—Ended Feb. —10 parts—45 cts. each).

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng–Began Aug. 10—11 parts to date —30 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng-Began Oct. 13—8 parts to date —15 cts. each).

26996. Statically Indeterminate Structures and the Principle of Least Work. Ill. (E–Began Nov. 9—4 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making (S E–Began Nov.—3 parts to date—15 cts. each).

27548. Constructive Engineering on the Pacific Coast. Ill. (I S F–Began Dec.—3 parts to date—30 cts. each).

28231. The Animal as a Prime Mover. R. H. Thurston (J F I–Began Jan.—2 parts to date —45 cts. each).

28263. The Handling of Men. Foster Crowell (E R–Began Jan. 5—3 parts to date—15 cts. each).

28353. Explosives and Their Modern Development. Vivian B. Lewes (J S A–Began Dec. 28—4 parts to date—30 cts. each).

28427. An American Engineer's Observations in Europe. J. F. Flagg (E R-Began Jan. 12—1 part to date—15 cts).

28838. The Contributions of Chemistry to the Methods of Preventing and Extinguishing Conflagrations. (Abridged.) Thomas H. Norton (J A C S–Began Feb.—1 part to date—45 cts).

28862. Distribution of the Echinoderms of Northeastern America. A. E. Verrill (A J S–Began Feb.—1 part to date—45 cts).

29082. The Second Lake Algonquin. Frank Bursley Taylor (A G–Began Feb.—1 part to date —45 cts).

NEW BOOKS OF THE MONTH

An Elementary Manual of Chemistry. By F. H. Storer, Professor of Agricultural Chemistry in Hartford University, and W. B. Lindsay, Professor of General and Analytical Chemistry, in Dickinson College. Being a revision and re-issue of Professor W. R. Nichols's Abridgment of Eliot and Storer's Manual. New York—Cincinnati—Chicago: American Book Co. [453 pp., 7⅛" × 5", cloth. Price, $1.20.]

THE original edition of this work was published in 1872. Two other editions have since been published, the last previous edition being in 1880. The work having proved by extensive use in the class-room a good text-book for elementary instruction, it is now brought up to date by a thorough revision. The work is, as indicated, an abridgment of Eliot and Storer's Manual, the task of abridgment having been done by the late Professor W. R. Nichols. One of the characteristic and most meritorious features of the treatise is the fact that it is written with a view to make the student rely upon his own experimental work in the laboratory in gaining his acquaintance with the fundamental and main facts of chemistry rather than upon class recitations. To this end experiments have been carefully selected, within the capacity of the students, and as carefully and minutely described, with illustrations of apparatus, &c., in order to surely guide the student in his experimental study. Every fact stated in the book is illustrated by some laboratory experiment of this kind. The authors explain in the preface that the book is not written in the interest of any particular theory, or of any one system of nomenclature or notation, and that their intention is to exhibit, so far as possible, within the limits proper to an elementary manual, the present state of chemical science and the relations of chemistry to its practical applications.

City Roads and Pavements. Suited to Oswego, New York. By William Pierson Judson, M. Am. Soc. C. E., M. Inst C. E. Oswego, New York: R. J. Oliphant, Printer, 1894. [Oct., 60 pp., flexible covers, and cloth.]

ALTHOUGH a great many books have been written upon the subject of pavements and road maintenance, this little book will have a place among the literature of road-making from the fact that it treats of roads specially adapted to towns of about the size of Oswego,—that is to say, containing about 25,000 inhabitants. It discusses the various methods which may and will be proposed for such towns, and the reasons why some are to be avoided and some are to be accepted and used. The author thinks that towns of this kind, contemplating the construction of streets, should profit by the costly experiences of others so far as applicable, and thus avoid building apparently cheap roads, whose repairs will afterwards make them cost more than those originally the most costly, or else costly ones which are not adapted to local needs or means. The whole discussion is based upon general reports and results culled from statistics of seventy-five cities, together with the recently-published floating literature upon the subject, written by experienced engineers and published in the technical journals. The book cannot fail to be of value to many municipal engineers and bodies of municipal officials.

Injectors, Their Theory, Construction, and Working. By W. W. F. Pullen, Assistant Lecturer and Demonstrator in Engineering at the University College of South Wales and Monmouthshire, Cardiff. With upwards of 100 illustrations. Manchester, England: The Technical Publishing Co., Ltd., 1893. [188 pp., 7"×4½".]

PERHAPS no other device used in steam engineering has a more meagre literature than injectors. This is the first instance, so far as we are aware, where an entire treatise has been devoted to the subject; and, lest the reader should suppose that the subject is not commensurate with the effort, it ought to be stated that all sorts of ejectors and injectors are included in the discussion. Thus, air injectors, blast-pipe connections, vacuum-brake ejectors, liquid-fuel injectors, steam injectors, injectors for live steam and for compound live steam, compound exhaust steam, lifting and non-lifting injectors, ejector condensers, re-starting injectors, and water lifters or jet pumps are only a few of the topics named and treated. The theory of the injector is discussed practically, scientifically, and mathematically. It is shown that the action of the injector may be calculated with extreme nicety, and that its action involves the grand principle of the conservation of energy. Upon this is built up the mathematical and scientific theory of its operation. Many engravings and diagrams illustrate the work, and tables for facilitating operations are presented.

Problems in Machine Design. By Charles H. Innes, M. A., Engineering Lecturer at the Rutherford College, Newcastle-on-Tyne. Manchester: The Technical Publishing Co., Ltd., 1894. [187 pp., 7"×4½", cloth.]

The author explains in the preface that his object in writing this book is to supply engineering students preparing for the Honor Stages of the science and art and technological examinations in machine construction and mechanical engineering, not merely with a collection of formulæ whose use is but little explained, but with a text-book containing examples showing how such formulæ may be applied to the solution of problems in machine design. Extensive use has been made of the writings of Professor Dwelshauvers-Déry in the chapter on Governors and of the writings of Mr. Young in the chapter on Springs. The publishers mention as a reason why this book should be published that in the report of the examiners of the science and art department in machine construction for the year 1892 some complimentary remarks were made as to the instruction given by the author to his Honors Stage Class.

Johnston's Electrical and Street Railway Directory. 5th Year. New York: The W. J. Johnston Co., Ltd., 1894. [8vo., 760 pp., cloth. Price $5.00.]

Probably none of the numerous annuals issued from the American Press are of greater utility than carefully-prepared and accurate trade directories. In many business houses the information afforded by these books is in constant request, and they are more or less valued, according to their accuracy and convenience for use. But the difficulties in securing absolute accuracy are so great that perfection can hardly be expected. Some errors will usually creep in unavoidably, and, therefore, the value of directories must be relative and comparative. The rapid growth and immense importance of the electric street-railway industries renders a directory of this kind a *sine qua non* to all commercial houses whose business is directly or indirectly connected therewith; and in this directory everything is so well classified, printed in such clear type, and arranged in so judicious a manner, that it may be consulted with the minimum expenditure of time. While the publishers do not claim that they have entirely avoided mistakes, they are evidently entitled to claim that this book is as reliable as could possibly be expected in lines of business wherein so many changes and extensions are constantly in progress. Names of managers, purchasing agents, owners, and, in short, all officials about whom information is likely to be desired, are given, together with a large amount of other statistical information relating to electrical and street railways.

The Centrifugal Pump. Turbines and Wate Motors. Including the theory and practice hydraulics. Specially adapted for engineers. By Charles H. Innes, M. A., Lecturer on Engineering at the Rutherford College, Newcastle-on-Tyne. With upwards of 130 illustrations. Manchester: The Technical Publishing Co., Ltd., 1893. [178 pp., 7"×4½".]

The author first deals with general hydraulic principles, and next takes up the discussion of pressure engines producing rotary motion. A third part is devoted to the discussion of turbines, whose power is obtained by altering the direction of motion and velocity of the water. A fourth part treats of the centrifugal pump, and the discussion is concluded by the consideration of the subject of hydraulic buffer stops. The assumption is made that the reader is prepared by a sufficient knowledge of statics, dynamics, and hydrostatics to deal with the mathematical equations necessary to the full exposition of the action of these machines. Frictional resistance and losses are expressed in simple mathematical form. These formerly presented difficulties, but their thorough theoretical and practical investigation has now so far removed the difficulties as to make passive resistances amenable to computation. The use of the elements of trigonometry in the attempt to master the subject of hydraulics is strongly advised. The whole forms a trustworthy addition to the literature of pumps, turbines, and water motors.

STREET-RAILWAY INVESTMENTS. A STUDY IN VALUES. By Edward E. Higgins. New York: The Street Railway Publishing Co , 1895. [8vo., 102 pp., cloth. Price $2.00.]

IN the preparation of this volume, which is mainly statistical, Mr. Higgins considers the street-railway securities in existence at the present time to represent, first, the purchase or valuation of the old horse-railway properties at a large advance on their original costs; second, the reconstruction and re-equipment of such properties accompanying the change of motor power at a cost usually in excess of that for which the same or superior work could now be done; third, the extension of the re-organized properties into the new territory; fourth, the development of entirely new properties in unoccupied territory; and, fifth, construction, promotion, and banking and brokerage profits. He presents questions which at present are creating some uneasiness in the public mind, and which are suggested by almost universal overcapitalization of costs and, in some instances, overcapitalization of earning power. He asks: "Will the growing confidence in street-railway investments be justified by results? Is the rapid development normal? Is it not a repetition on a smaller scale of the steam railway 'boom' of 1869-73, and will not disaster come?" He regards these questions as at present incapable of being answered wisely, and considers the present situation as one of fundamental changes, whose effect cannot now be estimated or predicted. He thinks, however, that it is not impossible even now to lay down certain principles which will serve to determine the limits of success in particular cases, and to establish broad lines of a theory of values in in this comparatively unknown financial field." A classification of surface railways in American cities and towns is based upon the number of inhabitants in the respective cities, and interurban electric railways are considered in a class by themselves. The treatise is full of valuable detailed information relating to cost and operation of roads in all parts of the United States. A further classification is made of systems in relation to the passenger income per capita per annum, and from this standpoint the author enters upon a very interesting and elaborate discussion of systems in groups, in which the passenger income lying between the same limits is worked out. In a pocket inside the cover is folded a removable sheet, 47″ × 16″, on which are printed two voluminous tables, one of which comprises statistics of capitalization, and the other statistics of operation of American street-railway systems. The amount of labor this represents may be comprehended when it is stated that these statistics have been compiled in the most exhaustive and thorough manner for no less than 145 different street-railway systems. These two tables are alone worth the price of the book.

THE SLIDE RULE. A PRACTICAL MANUAL. BY CHARLES N. Pickworth, Whitworth Scholar, Member of the Manchester Association of Engineers, &c., &c. Manchester: Emmot & Co., Ltd. New York: D. Van Nostrand Co., 1894. [56 pp. 5″×7″, flexible covers. Price 80 cents.]

THE use of the slide rule in drawing-rooms and engineers' offices is constantly increasing, as the labor-saving capacity of the instrument in making practical computations becomes more widely known and appreciated. Mr. Pickworth's book is intended to give practical examples and explanations of the use of the slide rule, so arranged as to form a practical course of instruction. Various slide rules are described, and the proper sizes for special uses are discussed. The mechanical principle and the mathematical principle involved in the notation are made plain to the understanding; and then a set of operations which cover the whole capacity of the instrument are successively presented.

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